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# THE PROXIMAL FEMORAL NAIL FOR THE TREATMENT OF UNSTABLE TROCHANTERIC FRACTURE

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# CERTIFICATE

This is to certify that the dissertation entitled "**The Proximal Femoral Nail For The Treatment Of Unstable Trochanteric Fracture"** is a bonafide record of work done by **Dr. A.V. SHABI,** in the Department of Orthopaedics, Government Rajaji Hospital, Madurai Medical College, Madurai.

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# DECLARATION

I **Dr. A.V. SHABI**, solemnly declare that the dissertation entitled "**THE PROXIMAL FEMORAL NAIL FOR THE TREATMENT OF UNSTABLE TROCHANTERIC FRACTURE"** has been prepared by me under the able guidance and supervision of my guide **Prof. V.Raviraman, M.S.Ortho., D.Ortho., Prof & HOD**, Department of Orthopaedics and Traumatology, Madurai Medical College, Madurai, in partial fulfillment of the regulation for the award of **M.S. (ORTHOPAEDIC SURGERY)** degree examination of the Tamilnadu Dr. M.G.R. Medical University, Chennai to be held in March 2010.

This work has not formed the basis for the award of any other degree or diploma to me previously from any other university.

Place : Madurai

Date :

**Dr.A.V.SHABI**

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# INTRODUCTION

Inter trochanteric fracture is one of the most devastating injuries in the elderly. The incidence of these fractures increases with advancing age. These patients are more limited to home ambulation and are dependent in basic and instrumental activities of daily living. 50 % of fracture around hip patients in elderly is of trochanteric fracture and these 50 % of fracture are unstable type of trochanteric fractures. The sliding hip screw device has been used for more than a decade for the treatment of these fractures. Though Zickel introduced his nail long ago, it was not a very popular fixation device due to higher incidence of complications. So was the case with Enders nail. The Zickel nail was later modified and renewed interest is being given to intramedullary fixation with devices like the Proximal Femoral Nail, Intramedullary Hip Screw and Gamma Nail due to shorter operating time, less blood loss and earlier mobilization with these devices. Side plate devices when used for unstable trochanteric fracture which are commonly associated with lateral wall communition results in excessive collapse of the proximal fragment and gross medialisation of distal fragment resulting in implant failure and delayed union or non union at fracture site. Intramedullary position of the PFN prevents the excessive collapse of proximal fragment & medialisation of distal fragment.

Being a intramedullary load sharing device, PFN helps in early post operative mobilization ,weight bearing and ultimately the early fracture union.

Being done as a closed nailing procedure PFN preserve the fracture haematoma and associated with less blood loss and short operating time.

## AIM OF THE STUDY

To assess the clinical, radiological and functional out come of unstable trochanteric fracture when treated with PFN.

# MECHANISM OF INJURY

Intertrochanteric fractures in young adults are the results of high energy trauma like road traffic accidents or fall from height. In contrast, 90 % of fractures occurring in the elderly are due to a simple fall. The tendency to fall increases with age and is exacerbated by several factors like poor vision, altered blood pressure, poor reflexes, decreased muscle power, vascular disease and co existing musculoskeletal pathology.

Cummins and Nevitt identified four factors that determine whether a particular fall results in a fracture of the hip. a) The fall must be oriented that the person lands on or near the hip, b) inadequate protective reflexes that do not reduce the energy of fall, c) deficient local shock absorbers (muscle and bone around the hip) d) insufficient bone strength at the hip – Osteoporosis.

## Signs and Symptoms

Fractures may be undisplaced or impacted and, such patients may present with minimal pain at the hip or may present with thigh pain. They may be ambulant. Whereas patients with displaced fractures are clearly symptomatic usually cannot stand and nonambulant.

Patients with undisplaced fracture may present with virtual absence of clinical deformity whereas those with displaced fracture exhibit the classical presentation of shortened and externally rotated extremity. There may be tenderness on palpation in the area of the greater trochanter. Ecchymoses may be present and should be noted.

## RADIOGRAPHIC AND OTHER IMAGING STUDIES

Standard radiographic examination includes AP view of the Pelvis and an AP and cross table lateral view of the proximal femur. The lateral radiograph can help to assess the posterior comminution of the proximal femur. An internal rotation view of the injured hip may be helpful to identify undisplaced fractures. Internally rotating the involved femur 10 to 15 deg offsets the anteversion of the femoral neck and provides a true AP view of the proximal femur .A second AP view of the contra lateral side can be useful for preoperative planning.

### CLASSIFICATION

The commonly used classification is the Boyd and Griffin classification

Boyd and Griffin Classification (1949): His classification included all fractures from the extracapsular part of neck to a point 5 cm distal to the lesser trochanter.

**Type 1:** Fractures that extend along the intertrochanteric line from the greater to the lesser trochanter. Reduction is usually simple and is maintained with little difficulty. Results are generally satisfactory.

**Type 2:** Comminuted fractures, the main fracture being along the Intertrochanteric line but with multiple fractures in the cortex. Reduction of these fracture are more difficult because the comminution can vary from slight to extreme. A particularly deceptive form of the fracture is one wherein there is an anteroposterior linear Intertrochanteric fracture occurs as in type 1 but with an additional fracture in the coronal plane.

**Type 3:** Fractures that are basically subtrochanteric with at least one fracture passing across the proximal end of the shaft just distal to (or) at the lesser trochanter. Varying degrees of comminution are associated. These fractures are usually more difficult to reduce and result in more complications, both during operation and during convalescence.

**Type 4 :** Fractures of the trochanteric region and the proximal shaft, with fracture in at least two planes, one of which usually in the sagital plane and maybe difficult to see in the routine anteroposterior roentgenograms. If open reduction and internal fixation are used two plane fixation is required because of the spiral, oblique or butterfly fracture of the shaft.

Evans devised a widely used classification system based on the division of fractures into stable and unstable groups. He divided the unstable fractures further into those in which stability could be restored by anatomical or near anatomical reduction and those in which anatomical reduction would not create stability. In Evans type 1 fracture, the fracture line extends upwards and outwards from the lesser trochanter, in type 2, the reverse obliquity fracture, the major fracture line extends outward and downward from the lesser trochanter. Type 2 fractures have a tendency towards medial displacement of the femoral shaft because of the pull of adductor muscles.

In Orthopaedic Trauma Association classification, Group 1 fractures are simple 2 part fractures, group 2 fractures are comminuted with a posteromedial fragment the lateral cortex of the greater trochanter however remains intact. Group 3 fractures are those in which the fracture line extends across both the medial and lateral cortices. This group includes the reverse obliquity pattern.

**Unusual Fracture Patterns**

Basicervical neck fractures are located just proximal to or along the intertrochanteric line. Though basicervical fractures are considered extracapsular, this may not always be the case. Basicervical fractures are thus at greater risk of osteonecrosis than the more distal intertrochanteric fractures. Furthermore, basicervical fractures lack the cancellous interdigitation seen with fractures through the intertrochanteric region which acts more likely to sustain rotation of the femoral head during implant insertion

**Applied Anatomy**

The intertrochanteric region of the hip consisting of the area between the greater and lesser trochanters represent a zone of transition from femoral neck to the femoral shaft. This area is characterized primarily by dense trabecular bone that serves to transmit and distribute stress similar to the cancellous bone of the femoral neck. The greater and lesser trochanters are the sites of insertion of the major muscles of the gluteal region, the gluteus medius and minimus, the iliopsoas and short external rotators. The Calcar femorale, a vertical wall of dense bone extending from the posteromedial aspect of the femoral shaft to the posterior portion of the femoral neck forms an internal trabecular strut within the inferior portion of the femoral neck and intertrochanteric region which acts as a strong conduit for stress transfer.

The musculature of the hip region can be grouped according to function and location. The abductors of the gluteal region, gluteus medius and minimus which originate from the outer table of the ilium and insert on to the greater trochanter function to control pelvic tilt in the frontal plane. The gluteus medius and minimus along with tensor fascia latae are also the internal rotators of the hip. The hip flexors are located in the anterior aspect of the thigh  include the sartorius, pectineus, iliopsoas and rectus femoris. Iliopsoas inserts on the lesser trochanter. Gracilis and the adductor muscles(longus, brevis and magnus) are located in the medial aspect of the thigh. The short external rotators, the piriformis, obturator internus. obturator extemus, superior and inferior gemelli and quadratus femoris all insert to the posterior aspect of the greater trochanter. The gluteus maximus originating from the ilium, sacrum and coccyx inserts onto the gluteal tuberosity along the linea aspera in the subtrochanteric region of the femur and the iliotibial tract.

**Treatment options**

Nonoperative treatment: Before the introduction of suitable fixation devices in the 1960s, treatment for intertrochanteric fractures was of necessity nonoperative, consisting of prolonged bed rest in traction until fracture healing occurred (usually 10 to 12 weeks) followed by a lengthy programme of ambulatory training. In elderly patients this approach was associated with high complication rates. Typical problems included decubitus ulcer, urinary tract infection, joint contractures, pneumonia and thromboembolic complications. In addition fracture healing was accompanied by varus and external rotation deformity and a shortened extremity because of the inability of traction in effectively counteracting the deforming muscular forces.

Indication of nonoperative treatment: 1) An elderly patient whose medical condition carries an excessively high risk of mortality from anaesthesia and surgery. 2) Non ambulatory patient who has minimal discomfort following fracture

Techniques of operative fixation have changed dramatically since the 1960s and the problems associated with early fixation devices have largely been overcome. Operative management consisting of fracture reduction and stabilization that permits early patient mobilization and minimizes many of the complications of prolonged bed rest, have consequently become the treatment of choice for intertrochanteric fractures.

Historically nonoperative management took one of the 2 different approaches. In first approach directed at early mobilization within the limits of patients discomfort the patient was allowed out of bed and in a chair within a few days of injury. Ambulation was delayed but the early bed to chair mobilization helped to prevent many of the complications of prolonged recumbency. A second approach in contrast attempted to establish and maintain a reasonable reduction via skeletal traction. The period of traction using this technique was prolonged and an acceptable position was difficult to achieve and maintain. Nursing care was also exceedingly difficult resulting in all the complications noted previously. When nonoperative management is required in the elderly usually the first approach is preferred.

## OPERATIVE TREATMENT

### Evolution of surgical techniques

Plate and screw devices: the first successful implants were fixed angle-nail plate devices, eg Jewett nail, Holt Nail consisting of a triflanged nail fixed to a plate at an angle of 130 to 150 degrees. While these devices provided stabilization of the femoral head and neck fragment to the femoral shaft, they did not affect fracture impaction. If significant impaction of the fracture site occurred the implant would either penetrate into the hip joint or cutout through the superior portion of the femoral head and neck. If on the other hand no impaction occurred lack of bony contact would result in either plate breakage or separation of the plate and screws from the femoral shaft. This experience with fixed angle nail plate devices indicated the need for a device that would allow controlled fracture impaction. This gave rise to sliding nail plate devices, eg, Massi Nail, Kenn Pugh Nail which consisted of a nail that provided proximal fragment fixation and a side plate that allow the nail to 'telescope" within a barrel. Impaction provided bone on bone contact, which promoted fracture union.

The sliding nail plate devices gave rise to sliding hip screw devices. A blunt ended screw replaced the nail portion with a large outside thread diameter. Theoretically these alterations would result in improved proximal fragment fixation and decreased the risk of screw cut out by eliminating the sharp edges found on triflanged nails. To accomplish a bi-directional sliding the plate was modified by replacing the round screw holes with slotted screw holes (Eggers Plate). More recently a 2-component plate device was introduced, the Medoff plate in which a central vertical channel constraints an internal sliding component. The Alta expandable Dome plunger is a modified sliding hip screw designed to improve fixation of the proximal fragment by facilitating cement intrusion into the femoral head. Cement is kept away from the plate barrel so that the devices sliding potential is maintained

**Intramedullarv Devices**

The various intramedullary devices that are being used for unstable intertrochanteric fractures are Proximal Femoral Naill(PFN), the Intramedullary Hip Screw (IMHS) and the Gamma Nail. These implants because of their intramedullary location are subjected to lesser bending moments than plate and screw devices.

Enders Nail was one of the earlier flexible intramedullary condylocephalic nails that were used for trochanteric fractures. But these implants were associated with higher rate of complications like rotational deformity, supracondylar femoral fracture, proximal migration of the pins through the femoral head, and back out of the nail with resulting knee pain and stiffness.

Cephalomedullary nailing devices like the PFN, the IMHS and the Gamma nail couple a sliding hip screw with a locked intramedullary nail. These devices offer Several Advantages, a) an intramedullary nail because of its location theoretically provides more efficient load transfer compared to a sliding hip screw. b) the short lever arm of the intramedullary device can be expected to decrease the tensile strain on the implant, thereby decreasing the risk of implant failure, c) because intramedullary fixation device incorporates a sliding hip screw, the advantage of controlled fracture impaction is maintained.

Intramedullary nailing is a more technically demanding procedure. Short intramedullary devices that extend into the mid shaft of the femur are associated with stress fractures at the tip of the nail, an incidence of 3 to 6% has been reported. Hence longer versions of these devices are being used that extend upto the supracondylar region of the femur. The intramedullary nails have been shown to have a proven benefit in unstable inter trochanteric fractures.

The PFN is an effective intramedullary load-sharing device. It incorporates the principles and theoretical advantages of the Zickel nail, Dynamic hip screw and locked intramedullary nail (Bellabarba et al.. 2000). Biomechanically the PFN is more stiff; it has a shorter moment arm (i.e., from the tip of the lag screw to the center of the femoral canal) whereas the DHS has a longer moment arm (i.e., from the tip of the lag screw to the lateral cortex). The DHS with a longer moment arm undergoes significant stress on weight bearing and hence higher incidence of lag screw cut out and varus malunion . The larger proximal diameter of the PFN additional stiffness to the nail Minimal blood loss, shorter operative time and early weight bearing are all the advantages of the PFN whereas the DHS has a longer operating time, more blood loss

**Reduction techniques**

Until devices became available that allowed postoperative fracture impaction, one had to achieve fracture stability at surgery to minimize the risk of healing complications. In the absence of a stable medial buttress the incidence of implant failure and hip joint penetration were very high. Among the methods subsequently developed to restore medial cortical continuity are medial displacement osteotomy (Dimon Hughston Osteotomy), Valgus osteotomy (Sarmiento osteotomy), Lateral displacement osteotomy (Wayne County Osteotomy).

A medial displacement osteotomy alters the pathologic anatomy of the unstable fracture such that it is converted into a stable albeit non-anatomic position. The surgical technique includes a) transverse osteotomy of the proximal femoral shaft at the level of the lesser trochanter b) osteotomy and proximal displacement of the greater trochanter and its attached abductor musculature c) medial displacement of the femoral shaft d) impaction of the proximal fragment into the medullary canal of the shaft. Limb shortening can occur to the extent that the proximal femur is impacted to the femoral shaft. This can be at least partially counteracted by the valgus positioning of the proximal fragment, which in turn however may interfere with the function and position of the knee.

Sarmiento recommended a valgus osteotomy for unstable intertrochanteric fractures to provide medial cortical buttress. This technique involves a) An oblique osteotomy of the proximal femoral shaft, extending from the base of the greater trochanter to a medial position 1 cm distal to the apex of the fracture, b) implant placement into the proximal femoral fragment, 90 degree to the fracture surface reduction and impaction of the osteotomy surfaces.

Wayne and County described the lateral displacement osteotomy, which involves lateral displacement of the femoral shaft to create medial cortical overlap. This technique is used for those relatively unstable intertrochanteric fractures with small posteromedial fragment.

Since the advent of sliding hip screws there has been a renewed interest in anatomic alignment. Hopkins et al reported on a series of 55 unstable intertrochanteric fractures treated with anatomic alignment or with medial displacement osteotomy and stabilized with sliding hip screws. 89 % of he fractures that were anatomically aligned subsequently collapsed into a medially displaced position and 97 % of the same fractures united without any complication. The author concluded that the only advantage of medial displacement osteotomy was a slightly lower rate of trochanteric bursitis secondary to less fracture impaction and screw sliding.

**Unstable fractures**

The most common unstable intertrochanteric fractures exhibit loss of the posteromedial buttress. Another type of unstable intertrochanteric fracture is the reverse obliquity pattern, which begins just proximal to the lesser trochanter and extends laterally. Follow a general approach similar to that recommended for stable fracture patterns in the preceding section: anatomic fracture alignment followed by internal fixation using a sliding hip screw. In older patients, the posteromedial fragment is usually ignored. In younger patients, an attempt should be made to stabilize a large posteromedial fragment in a near-anatomic position to prevent excessive screw-barrel slide, which would result in limb shortening. Furthermore, axial loading studies of unstable fractures have confirmed that reduction and fixation of the posteromedial fragment becomes progressively more important with increasing fragment size.

Reduction and stabilization of the posteromedial fragment can be performed either before or after application of the lag screw and side plate. The former method facilitates anatomic fracture reduction of the posteromedial fragment. If the main fracture fragments are reduced and stabilized first it may be impossible to reduce the posteromedial fragment anatomically.

To mobilize and reduce the posteromedial fragment, there should be no traction on the lower extremity; since the iliopsoas is attached to the lesser trochanter. traction results in proximal migration of the posteromedial fragment. The extremity is externally rotated to better expose the posteromedial area of the femoral shaft. The posteromedial fragment can be reduced using a bone hook and provisionally stabilized using a Verbrugge or standard reduction clamp. Definitive fracture fixation involves use of either one or more cerclage wires or one or more lag screws directed from anterolateral to posteromedial. These screws cannot be inserted through the proximal hole of the plate, as proper angulation cannot be achieved because of the limitations of the screw hole.

Once the posteromedial fragment is stabilized, traction is placed on the lower extremity and two main fragments reduced. The sliding hip screw is then inserted as previously described.

**Basicervical Fractures**

Since basicervical fractures-those located just proximal to or at the intertrochanteric Line -are adjacent to the femoral neck region, some authors have advocated the use of multiple cancellous screws for fracture stabilization .The fracture pattern seen with a basicervical fracture, however, is more lateral than either the subcapital or transcervical fracture, thereby creating an increased varus moment at the fracture site. This, in turn, may result in toggling of multiple cancellous screws at their insertion points through the lateral cortex. The side plate of the sliding hip screw prevents screw toggling, theoretically reducing the risk of varus displacement . In addition, a sliding screw-plate device permits controlled fracture impaction.

When using a sliding hip screw for treatment of basicervical fracture, however, one must make a few modifications to the technique used for more distal intertrochanteric fractures. Because insertion of lag screw into the femoral head and neck may cause the proximal fragment to rotate, so two guide pins are inserted, one in an inferior position and the second more superior. The sliding hip screw is placed over the inferior guide pin, while the proximal guide pin (or cannulated cancellous screw) helps to prevent rotation of the femoral head and neck segment.

**Intertrochanteric Fractures with Subtrochanteric Extension**

When they were first used, sliding hip screws were not recommended for fractures extending into the subtrochanteric region, but improvements in material properties and design have broadened the indications for these devices. Mullaji and Thomas, reporting on a series of 42 peritrochanteric and subtrochanteric fractures so treated, found that at an average follow-up of 11 months 91% of the surviving patients had united statisfactorily.

When treating an intertrochanteric fracture with subtrochanteric extension using a sliding hip screw, one should reduce and provisionally stablilize the subtrochanteric component, using lag screws or cerclage wire, prior to sliding hip screw insertion. This can be accomplished on the fracture table by releasing the traction and manipulating the extremity as needed. Once the subtrochanteric component has been reduced and stabilized, traction is reapplied and the position of the femoral head and neck component checked on both AP and lateral views. Placement of the sliding hip screw then proceeds as described above. Whenever possible, screws passed through the plate should be placed as lag screws to stabilize the subtrochanteric fracture component. The distal extension of the fracture necessitates a longer plate than with a pure intertrochanteric fracture with eight to ten cortical purchase in the distal fracture fragment.

## Comminution and Displacement of the Greater Trochanter

Because of the importance of the greater trochanter as the site of insertion for the abductor muscles, fractures that result in its comminution or displacement require special attention. If displaced, a tension-banding technique is used to reattach the greater trochanter and preserve or restore abductor tendon . With the plate stabilized to the femoral shaft, the cerclage wire is tightened to provide secure reattachment

## Prosthetic Replacement

Primary prosthetic replacement has had limited use in a acute intertrochanteric fracture management. Successfully treated by internal fixation. However, some elderly patients who sustain a comminuted unstable intertrochanteric fracture experience loss of reduction of fixation and require revision surgery. This population of patients would benefit most from primary-prosthetic replacement. However, it is virtually impossible to identify these patients prior to surgery.

The only indications for primary prosthetic replacement after intertrochanteric fracture considered by us are (a) symptomatic ipsi-lateral degenerative hip disease (total hip replacement), and (b) attempted open reduction and internal fixation (ORIF) that cannot be performed because of extensive comminution and poor bone quality.

**Composite Fixation**

Introduced by Harrington as a means of enhancing internal fixation, use of adjunctive methylmethacrylate ("bone cement") has been advocated in patients with severe osteopenia who have sustained a comminuted, unstable intertrochanteric. Muhr et. al. emphasized that the purpose of the cement is to maintain stability of the fracture- implant construct until osseous union occurs; these authors, who treated 231 intertrochanteric fractures with cement augmentation, argued that the cement provides the stability necessary for immediate weight bearing after surgery.

Reporting on a series of 38 unstable intertrochanteric fractures whose treatment included cement augmentation, Cheng et al. found that 76% had a good or excellent result at an average follow-up 3.7 years. Late complications occurred in six patients and included non-union, screw protrusion, partial destruction of the femoral head, subcapital fracture head. All complications occurred at least 1 year after surgery and were attributed to inappropriate placement and /or excessive amounts of cement resulting in inadequate new bone formation.

Methylmethacrylate can be used to enhance lag screw fixation within the femoral head or fixation of the plate-holding screws, depending on the area of compromised fixation. When employing this technique, it is essential to obtain good fracture impaction at surgery.

Soft tissues and cement intrusion into the fracture site, which could interfere with healing .The technique for methylmethacrylate enhancement of the lag screw and plate-holding screws is similar and involves screw insertion followed by screw removal, injection of liquid methylmethacrylate by syringe into the empty screw hole, and screw reinsertion. Precooling the cement monomer gives the surgeon more time for the procedure. It is interesting to note that if the screw is turned as the methylmethacrylate hardens and the screw track is then drilled and tapped, its holding power is also diminished. Therefore, the screw should be fully placed in the cement while it is still soft and tightened after the cement has set.

**Pathologic Fractures**

Operative treatment is indicated for most pathologic intertrochanteric fractures. This treatment approach maximizes patient function, alleviates pain, facilitates nursing care, decreases the duration and cost of hospitalisation, and improves morale.

Composite fixation, consisting of a sliding hip screw supplemented with methylmethacrylate to fill the voids left by removal of macroscopic tumor; (b) locked intramedullary nailing; and (c) proximal femoral replacement. Composite fixation with a sliding hip screw has been described by Walling and Banner.

Proximal femoral replacement can be used for those lesions that are too extensive for composite fixation. The main disadvantage of proximal femoral replacement is the mandatory need for reattachment of the hip abductors. Proximal femoral replacement with a long-stem component has the advantage, however, of providing prophylactic fixation of more distal femoral shaft lesions.

**Polytrauma Patients**

Polytrauma patients (typically young adults who have experienced high-energy trauma) should undergo immediate stabilization of all long-bone fractures.

Ipsilateral intertrochanteric- femoral shaft fractures occur less frequently than do concomitant femoral neck- shaft fractures. If the hip and shaft fractures are in close proximity, a sliding hip screw with a long side plate may suffice; this is by far the simplest and most effective means of stabilizing the two adjacent fractures. One attractive treatment option is to stabilize the intertrochanteric fracture with a sliding hip screw and the femoral shaft fracture with an interlocked retrograde nail. If the femoral shaft fracture is transverse and not comminuted, retrograde inserted Ender nails can be used for femoral-shaft fixation in conjunction with a sliding hip screw. It is possible to use a cephalomedullary nail with screws anchored in the femoral head and neck, but results are poorer for stabilization of ipsilateral intertroclianteric-femoral shaft fractures than for ipsilateral femoral neck-shaft fractures.

**Proximal Femoral Nail**

Evaluation of the appropriateness of an intramedullary device and estimation of nail diameter, lag screw angle, and length are performed using preoperative radiographs and templates. If there is a severe bowing of the affected femur or other associated deformity, use of an intramedullary device may be contraindicated. The patient is positioned supine on a fracture table, with both lower extremities resting in padded foot holders. The fracture is reduced as described with the use of a sliding hip screw, and the leg is placed in neutral or slight adduction to facilitate nail insertion through the greater trochanter; contra lateral leg is positioned so as to allow an unimpeded lateral radiograph. Since it is extremely difficult to insert an intramedullary nail with the hip abducted, abduction of the lower extremity is not used to correct the varus malreduction. Although it is possible to insert the intramedullary nail component of the device with the fracture unreduced and the leg adducted, followed by fracture reduction and lag screw insertion with the leg abducted, doing so can be very difficult technically. Therefore, if a varus reduction cannot be corrected without placement of the leg in abduction, it is preferable either to perform an open reduction with direct fracture exposure or to use a sliding hip screw for fracture stabilization. A lateral straight incision is made from tip of the greater trochanter extending proximally for 4 to 6 cm; the gluteus medias muscle is dissected in line with its fibers. If an open reduction is required, one can extend the incision distally, incising the iliotibial band in the line with the skin incision. In this case, the vastus lateralis muscle is reflected anteriorly to expose the proximal femoral shaft. The entry point for an intramedullary hip screw is at the tip of the greater trochanter, halfway between its anterior and posterior extent. In younger individuals, particularly those with subtrochanteric fractures, it may be necessary to ream the femoral isthmus to accommodate the intramedullary nail; a ball tipped guide wire can be placed down the femoral shaft and a flexible cannulated reamer used to enlarge the proximal shaft to the appropriate diameter. In the elderly who have larger diameter medullary canals, this step is usually not necessary. The appropriately sized intramedullary nail is then assembled with its corresponding intramedullary angle guide attachment. It is imperative that the appropriate angle guide targets the proximal and distal holes in the nail using the drill sleeves and guide pin prior to device insertion. The nail is inserted by hand through the greater trochanter into the proximal femur. One should avoid use of excessive force, which may produce comminution of the proximal femoral shaft. It is also important to use frequent fluoroscopic evaluation to follow the progression of the nail as it is inserted

The nail is positioned to allow proper positing of compression screw and derotation screw in the femoral neck and head. The drill sleeves are inserted into the angle attachment and pushed up to the lateral femoral cortex. It is important that the sleeves rest against bone and not the vastus lateralis muscle. The threaded guide pin is then inserted through the sleeves into the femoral neck and head using image intensification and advanced until it is 5 to 10 mm from the hip joint. Guide wire for compression screw should lie in the inferior part of the neck and  for derotation screw in the superior part of the neck such that while passing the screw there will not be any cortical breach. If the guide pin is not correctly positioned, it should be removed and the nail position confirmed.

A cannulated reamer is advanced over the guide pin to the appropriate depth and then compression & derotation screw inserted.

Distal targeting, is performed using the drill sleeves. One must verify radiographicalry that the distal screws have passed through the nail

**POSTOPERATIVE FRACTURE CARE**

The mobilization of hip fracture patients out of bed begin and ambulation training be initiated on postoperative day1. Furthermore, any patient who has been surgically treated for an intertrochanteric fracture should be allowed to bear weight as tolerated.

Restricted weight bearing after hip fracture has little biomechanical justification, since activities such as moving around in bed and use of a bedpan generate forces across the hip approaching those resulting from unsupported ambulation. Even foot and ankle range-of-motion exercises performed in bed produce substantial loads on the femoral head secondary to muscle contraction.

Several studies have demonstrated that unrestricted weight bearing does not increase complication rates following fixation of intertrochanteric fractures.

# COMPLICATIONS

## Loss of Fixation

Fixation failure with a sliding hip screw is most commonly characterized by varus collapse of the proximal fragment with cut -out of the lag screw from the femoral head. The incidence of fixation failure with DHS is reported to be as high as 20% in unstable fracture patterns. Lag screw cutout from the femoral head generally occurs within 3 months of surgery and is usually due to (a) eccentric placement of the lag screw within the femoral head (b) improper reaming that creates a second channel; (c) inability to obtain a stable reduction; (d) excessive fracture collapse such that the sliding capacity of the device is exceeded; (e) inadequate screw-barrel engagement, which prevents sliding; or (f) severe osteopenia, which precludes secure fixation.

**Factors influencing loss of fixation are**

1. unstable trochanteri #
2. biomechanically long lever arm
3. eccentric placement of lag screw
4. inadequate bone stock

Loss of fixation is minimized with PFN

- ❖ By intramedullary position of Nail
- ❖ Biomechanically shorter moment arm
- ❖ Prevent the excessive collapse of the Proximal fragment
- ❖ Prevent gross medialisation of the distal fragment

Achieving a stable reduction with proper insertion of the sliding hip screw is the best way of preventing postoperative loss of fixation. Rarely, fixation failure results from loss of fixation of the plate -holding screws.

When fixation failure occurs, management choices include (a) acceptance of the deformity; (b) revision ORIF, which may require methylmethacrylate; (c) conversion to prosthetic replacement. Acceptance of the deformity should be considered in marginal ambulators with high surgical risk. Revision ORIF is indicated in younger patients, while conversion to prosthetic replacement (unipolar, bipolar, or total hip replacement) is a preferred in the elderly patient with osteopenic bone.

**Nonunion**

Nonunion following surgical treatment of intertrochanteric fracture occurs in less than 2%of patients; its rare occurrence is largely due to the fact that the fracture occurs through well-vascularized cancellous bone. The incidence of nonunion is highest in unstable fracture patterns. Mariani and Rand et. al. 1987 reported on 20 cases of nonunions, 19 of which (95%) occurred in fracture with loss of posteromedial support. Most intertrochanteric nonunions follow unsuccessful operative stabilization, with subsequent varus collapse, screw cutout through the femoral head. Another possible etiology for intertrochanteric nonunion is an osseous gap secondary to inadequate fracture impaction. This can occur as a result of "jamming" of the lag screw within the plate barrel or mismatch of the lag screw and plate barrel length leading to the loss of available screw barrel slide. Both problems can be avoided with proper attention to the details of device insertion.

Intertrochanteric nonunion should be suspected in patients with persistent hip pain that have radiographs revealing a persistent radiolucency at the fracture site 4 to 7 months after fracture fixation. Progressive loss of alignment strongly suggests nonunion, although union may occur after an initial change in alignment, particularly if fragment contact improves. Abundant callus formation may be present making the diagnosis of nonunion difficult to confirm. Tomography evaluation may help to confirm the diagnosis; otherwise the diagnosis may not be possible until the time of surgical exploration. As with any nonunion, the possibility of an occult infection must be considered and excluded. In some cases, with good bone stock, repeat internal fixation combined with a valgus osteotomy and bone grafting can be considered however, in most elderly individuals, conversion to a Calcar replacement prosthesis is preferred.

## Malrotation Deformity

The usual cause of malrotation deformity after intertrochanteric fracture fixation is internal rotation of the distal fragment at surgery. In unstable fracture patterns, the proximal and distal fragments may move independently; in such cases, the distal fragment should be placed in neutral to slight external rotation during fixation of the plate to the shaft. When malrotation is severe and interferes with ambulation, revision surgery with plate removal and rotational osteotomy of the femoral shaft should be considered.

**Other complications**

Osteonecrosis of the femoral head is rare following intertrochanteric fracture. No association has been established between location of the implant within the femoral head and the development of osteonecrosis, although one should avoid the insertion of hip screw in the posterio superior aspect of the femoral head because of the proximity of the lateral epiphyseal artery system.

Various case reports have documented unusual complications relating to lag screw-side plate separation and lag screw migration into the pelvis. Lag screw -side plate separation can be prevented by using a compression screw if there appears to be inadequate screw-barrel engagement. Most cases of lag screw migration into the pelvis occur in unstable fractures and are associated with improper reaming and violation of the hip joint or the presence of inadequate screw-barrel engagement.

Laceration of the superficial femoral artery by a displaced lesser trochanter fragment has been reported, as well as binding of the guide pin within the reamer, resulting in guide pin advancement and subsequent intraarticular or intrapelvic penetration.

**‘Z’ Effect**

‘Z’ effect is a peculiar complication of PFN. PFN is fixed with 2 screws ; the larger (lag) screw is designed to carry most of the load, and smaller screw (the hip pin) is to provide rotational stability. If the hip pin is longer than the lag screw, vertical forces would increase on the hip pin and start to induce cut-out, a knife effect or Z-effect. This might force the hip pin to migrate into the joint and the lag screw to slide laterally. The cut-out rate with a PFN is reportedly 0.6 to 8%. Although complication rates remain low, cut-out of either screw is a serious complication, which can lead to revision surgery and related morbidity. When the hip pin was 10mm shorter than the lag screw, the percentage of the total load carried by the hip pin ranged from 8 to 39% (mean, 21%), no cut-out of the femoral head and no unacceptable implant or fracture displacement were observed.

**Post Operative Femoral Shaft Fracture**

Older generation cephalomedullary Nails had very large distal locking screw near the tip of the Nail with associated risk of stress riser near the Nail Tip causing post operative femoral shaft fracture near the Nail tip.

In PFN stress riser effect is decreased by the tapered distal end of the Nail and the distal locking screws are placed more proximally on the Nail.

**Materials & Methods**

At our institution we selected 12 cases (13 hips – one patient had bilateral unstable trochanteric fracture) of unstable trochanteric fractures for this prospective study.

All (12 patients) 13 hips were treated with Proximal Femoral Nail in which (11 patients) 12 hips came for regular follow up and they were included in the study. The age group varied from a minimum of 22 years to a maximum of 70 years and average age was 42.8 years. Duration of the study was from June 2007 to May 2009. Mean follow up was 10 months of the 11 patients 9 were male and three were female. Right side involved in 8 cases Left side involved in 4 patients. 9 patients were manual laborers, two were sedentary workers.

All the fractures were classified according to Boyd & Griffin classification for Inter- trochanteric fractures. Only type III & Type IV were included in the study.

**MODE OF INJURY**

| | | |
|---|---|---|
| RTA (Road traffic Accidents) | : | 9 |
| Accidental fall | : | 3 |

**Associated Injuries**

Comminuted Olecranon Fracture 1 case on same side

The average interval from the injury to the time of surgery was 6.8 days.

All the patients were managed initially with skeletal traction before taking up for surgery. The patient with comminuted olecranon fracture was treated by ORIF with plate osteosynthesis on the same day when he was treated for trochanteric fracture.

**Pre operative planning**

Pre operative templating with AP – Roentgenogram of injured hip was used to measure the nail diameter and lag screw length.

**Implants & Instruments**

| | |
|---|---|
| Length of short PFN - $135^0$ | 25 cm |
| Length of Long PFN - $135^0$ | 36, 38, 40, 42 cm |
| Proximal Diameter | 15mm |
| Proximal Nail Angulation | $6^0$ |
| Distal diameter | 9, 10, 11,12mm |
| Lag screw diameter | 8 mm |
| Derotation screw diameter | 6.2mm |
| Distal locking bolt | 4.9mm |

Jig for proximal and distal reamers & for locking

Guide wire 2 mm

Canulated step reamer

guide wire sleeve & drill sleeve

**Anaesthesia, positioning & image intensifier**

Surgery was done in standard radiolucent fracture table with patient in supine position with use of image intensifier. Sub Arachnoid block was used for all patients.

SCB used for one patient for ORIF of olecranon frcture.

**Surgical technique**

All the fractures were treated with initial closed reduction with alignment of the medial cortex. In two patients we could not achieve closed reduction and in those cases open reduction was done.

**Incision**

The approach for PFN is a 5 cm incision extending proximally from the tip of the greater trochanter followed by careful separation of the abductors.

**Entry point**

The point of entry is the tip of the greater trochanter at the mid point in the anteroposterior diameter and is made with a curved awl under c- arm guidance.

**Guide wire insertion & reaming**

The guide wire is inserted using a tissue protector. The position of guide pin is checked in AP and lateral views. Entry point is reamed using 15mm entry point reamer and distal reaming of canal is done with graded canulated reamers, when ever necessary.

**Nail Insertion & Proximal targeting**

The nail is inserted with the help of the jig over the guide wire. Fluoroscopic images are taken when the nail is being introduced to check for any peroperative femoral fractures. The nail along with the jig is inserted by hand by gentle twisting movements. Once the nail is positioned appropriately the guide wire is removed and drill sleeve are attached to the jig and through a stab incision over lateral thigh the drill sleeves are pushed upto the lateral cortex one for compression screw and one for derotation screw. The guide pin is then passed into the head & neck using guide pin sleeve. The guide pins are advanced upto 5mm short of articular surface of femoral head.

Proximal locking with the compression screw along the inferior part of the neck is done first followed by the superior derotation screw of appropriate length as measured preoperatively & peroperatively .

**Distal Targeting**

Distal locking is also done with the aid of jig and two distal locking screws.

For long PFN – distal locking is done with free hand technique.

Operating time was calculated from the start of surgical incision to wound closure and the duration of image intensifier in patient treated with the PFN was calculated in seconds. Blood loss was calculated from the number of surgical mops that were used, each mops corresponding to 50ml of blood.

Operative time varied from 43 minutes to 88 minutes with average of 67.6 minutes

Blood loss varied from 150 ml to 325 ml with mean of 227 ml

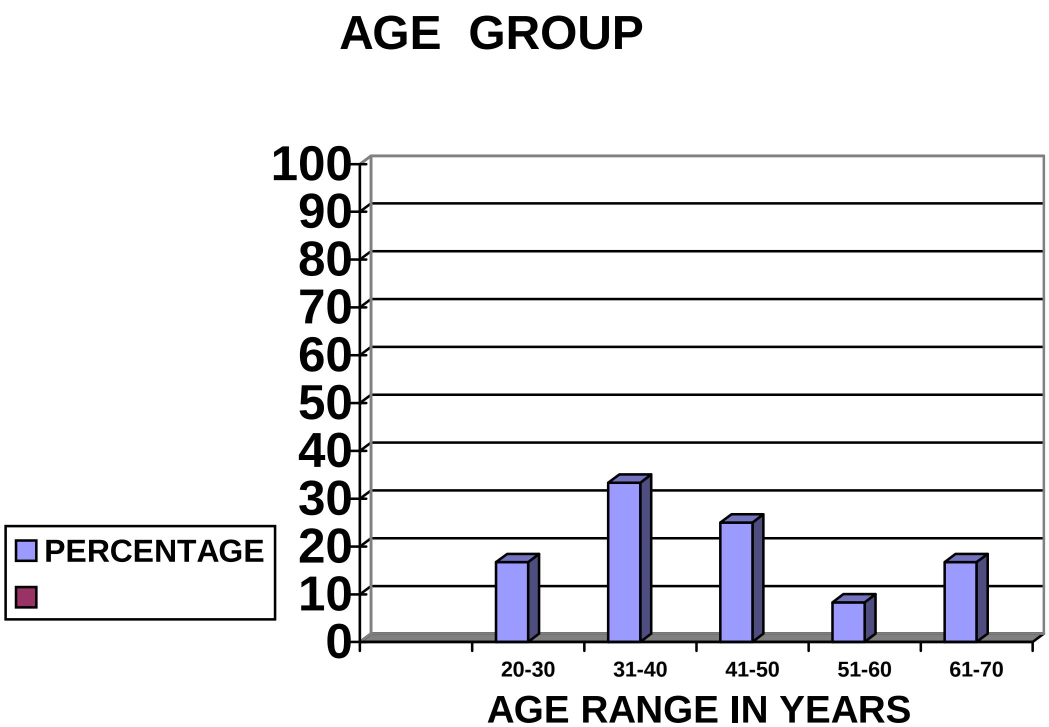
Complication were encountered intraoperatlvely like breakage of the reamer of Proximal derotation screw, which was left alone.

**Post operative Protocol**

Knee and hip mobilization started on first post operative day.

Patients were allowed partial weight bearing with aid, as tolerated. Sutures were removed on the $12^{th}$ post operative day. In one patient who had bilateral Trochanteric fracture rehablitation was delayed.

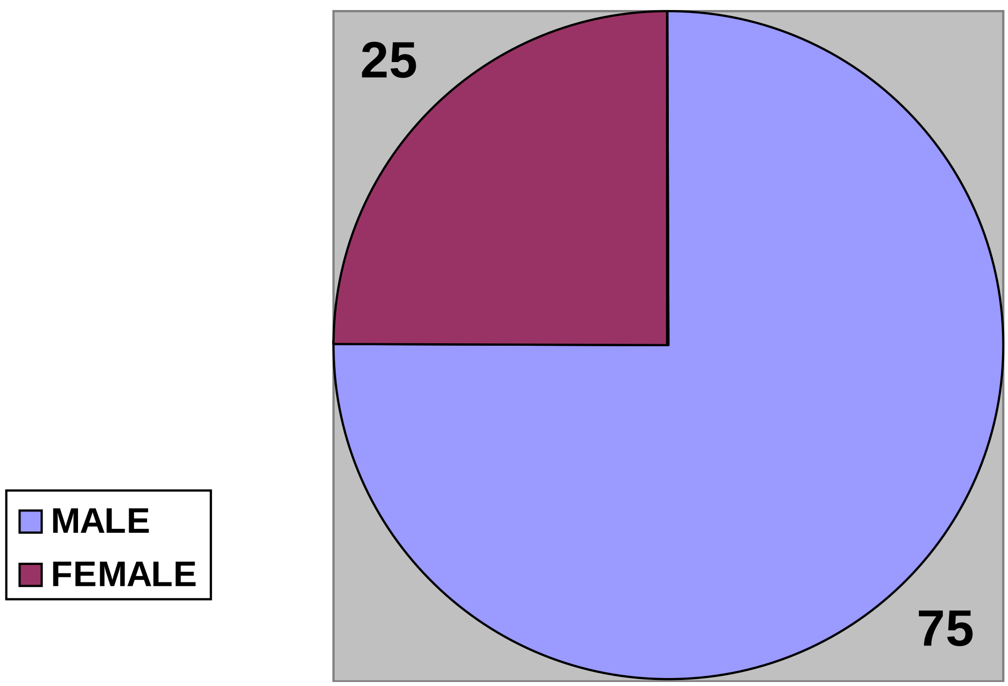
Time for fracture healing was evaluated according to radiographic and clinical criteria. Clinically Union was observed as the absence of Tenderness (or) pain with full weight bearing.


AGE GROUP
100
90
80
70
60
50
40
30
20
10
0
PERCENTAGE
20-30
31-40
41-50
51-60
61-70
AGE RANGE IN YEARS

# AGE GROUP PATTERN

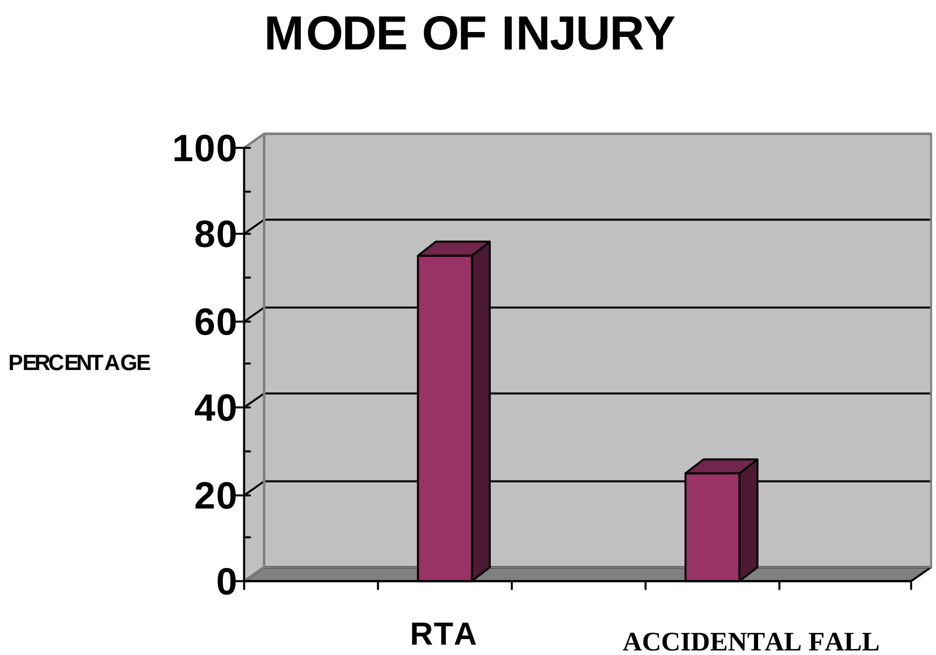
| AGE GROUP | PFN | |
|---|---|---|
| | NO. | % |
| 20 -30 | 2 | 16.7 |
| 31 – 40 | 4 | 33.3 |
| 41 – 50 | 3 | 25 |
| 51 – 60 | 1 | 8.3 |
| 61 – 70 | 2 | 16.7 |
| **TOTAL** | **12** | **100** |
| MEAN | **42.8** | |

SEX RATIO



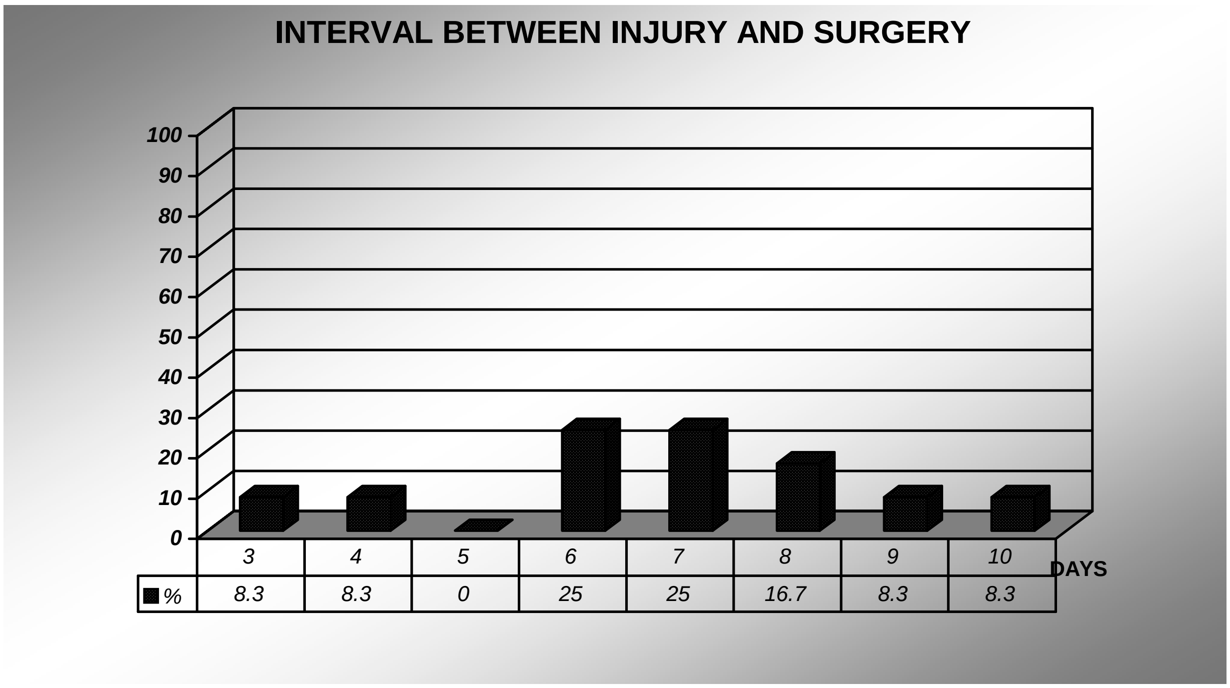
# SEX RATIO

| SEX | PFN | |
|---|---|---|
| | NO; | % |
| MALE | 9 | 75 |
| FEMALE | 3 | 25 |


MODE OF INJURY
100
80
60
40
20
0
PERCENTAGE
RTA
ACCIDENTAL FALL

# MODE OF INJURY

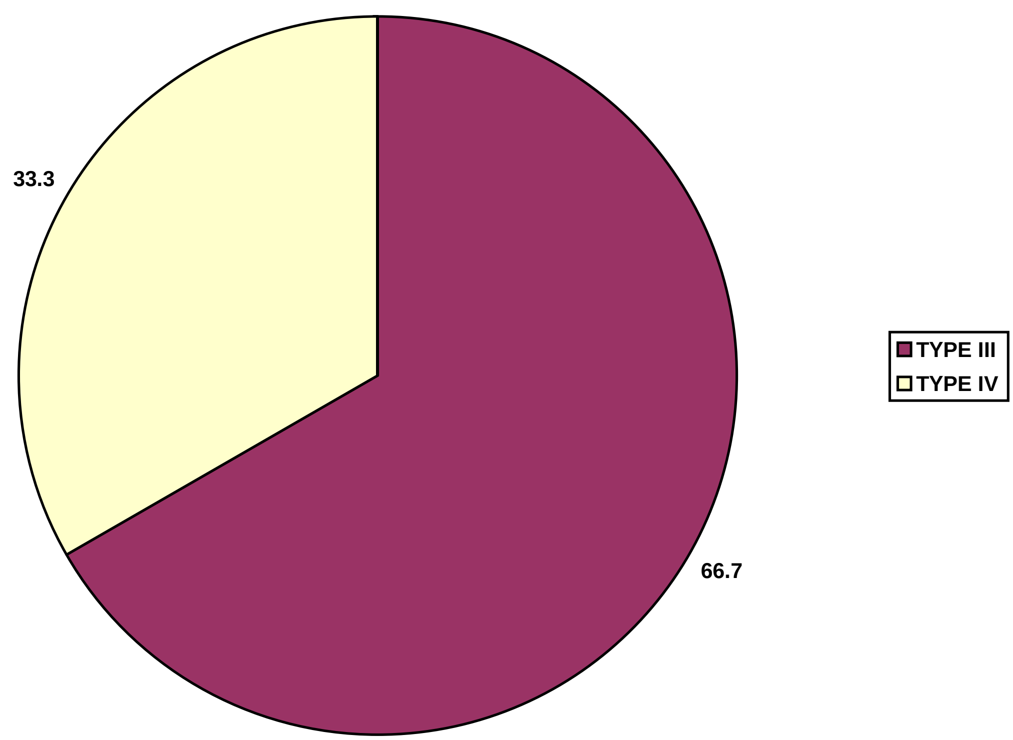
| **MODE** | **PFN** | |
|---|---|---|
| | **NO;** | **%** |
| RTA | 9 | 75 |
| ACCIDENTAL FALL | 3 | 25 |


INTERVAL BETWEEN INJURY AND SURGERY
100
90
80
70
60
50
40
30
20
10
0
3
4
5
6
7
8
9
10
DAYS
%
8.3
8.3
0
25
25
16.7
8.3
8.3

## INTERVAL BETWEEN INJURY & SURGERY

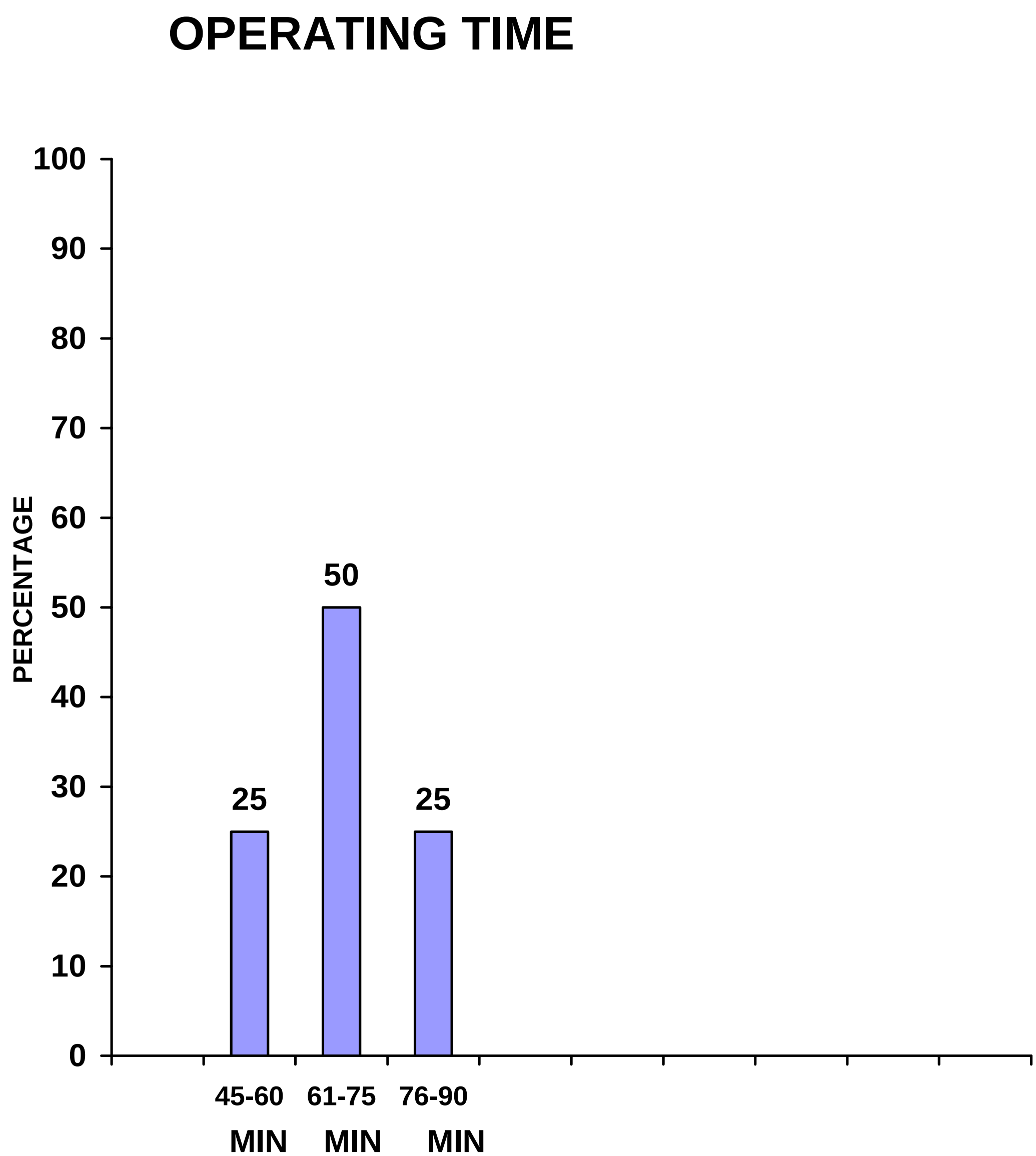
| INTERVAL IN DAYS | PFN | |
|---|---|---|
| | NO; | % |
| 3 | 1 | 8.3 |
| 4 | 1 | 8.3 |
| 5 | 0 | 0 |
| 6 | 3 | 25 |
| 7 | 3 | 25 |
| 8 | 2 | 16.7 |
| 9 | 1 | 8.3 |
| 10 | 1 | 8.3 |
| >10 | 0 | 0 |
| MEAN | | 6.8 |

**FRACTURE PATTERN ACCORDING TO BOYD & GRIFFIN CLASSIFICATION**



# CLASSIFICATION

| BOYD & GRIFFIN CLASSIFICATION | PFN | |
|---|---|---|
| | NO; | % |
| TYPE I | 0 | 0 |
| TYPE II | 0 | 0 |
| TYPE III | 8 | 66.7 |
| TYPE IV | 4 | 33.3 |

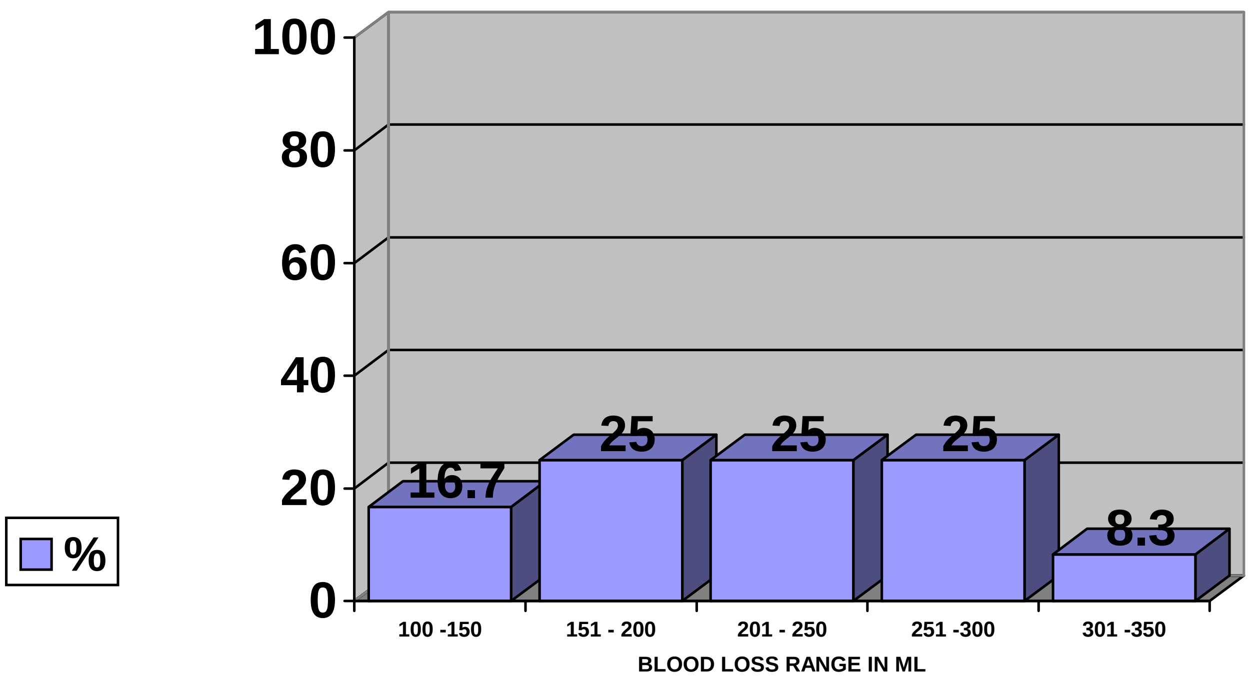


OPERATING TIME
PERCENTAGE
100
90
80
70
60
50
40
30
20
10
0
25
50
25
45-60 MIN
61-75 MIN
76-90 MIN

# OPERATING TIME

| OPERATING TIME ( MIN) | PFN | |
|---|---|---|
| | NO | % |
| 45 – 60 | 3 | 25 |
| 61 – 75 | 6 | 50 |
| 76 – 90 | 3 | 25 |
| >90 | 0 | 0 |

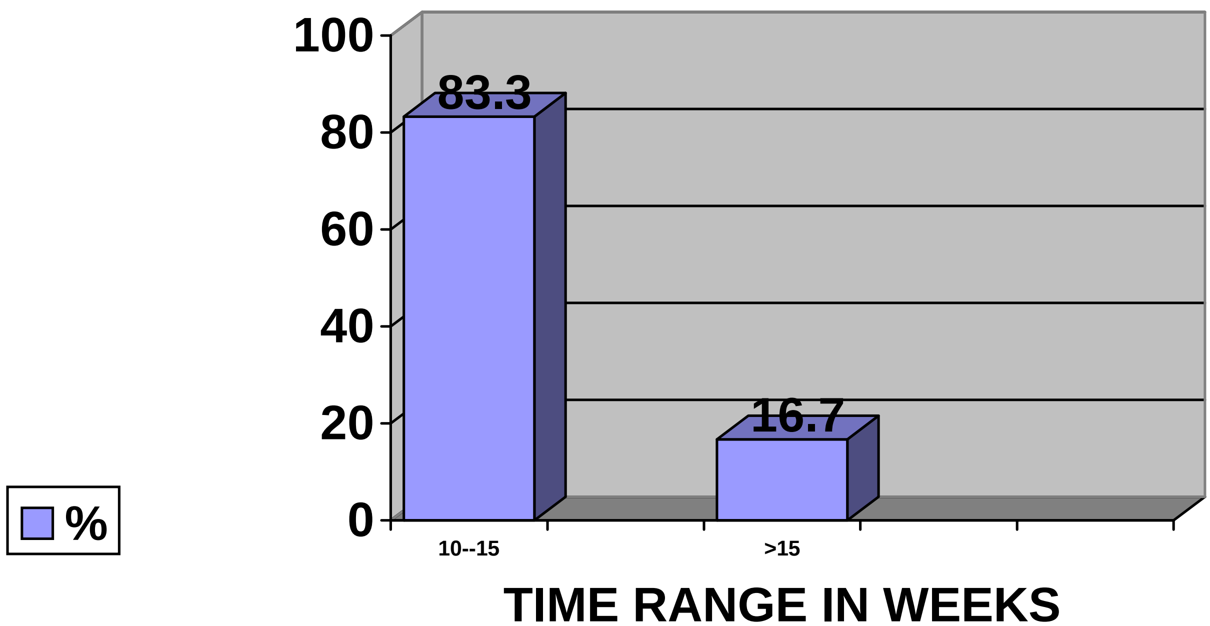
BLOOD LOSS DURING SURGERY



## BLOOD LOSS

| BLOOD LOSS (ml) | PFN | |
|---|---|---|
| | **NO** | **%** |
| 101 – 150 | 2 | 16.7 |
| 151 – 200 | 3 | 25 |
| 201 – 250 | 3 | 25 |
| 251 – 300 | 3 | 25 |
| 301 – 350 | 1 | 8.3 |
| **MEAN LOSS** | **227** | |

TIME FOR FRACTURE UNION



# TIME FOR FRACTURE UNION

| **TIME (weeks)** | **PFN** | |
|---|---|---|
| | **NO;** | **%** |
| <10 | 0 | 0 |
| 10 – 15 | 10 | 83.3 |
| >15 | 2 | 16.7 |
| MEAN | 13.3 | |

Patients were evaluated clinically and radiologically at 3 weeks interval for first 3 months and there after monthly for the next 3 months and bimonthly for next 12 months. During follow up the Harris Hip Score was evaluated at 3 months and 6 months post operatively. Various parameter like pain, limp, use of support, distance walked, stair climbing, sitting, absences of deformity, range of motion were evaluated using Harris Hip Score.

**Results**

| | |
|---|---|
| Operating Time | **67.6 min** |
| Blood Loss | **227 ml** |
| Abductor Lurch | **2 cases** |
| Varus deformity | **1** |
| Screw Back out | **1** |
| Fracture Union | **13.3 weeks** |
| Image Intensifier | **117 Sec** |
| Harries Hip score at 6months | **84.3** |

Average operating time was 67.6 minute for patient treated with the PFN. Blood loss has varied from 150ml to 325ml with an average of 227 ml. Mean usage of image intensifier was 117 sec. Abductor lurch was seen in two patients.

Average union time in weeks is 13.3 weeks.

All the patient were allowed for partial weight bearing from the 2-3rd pod with aids. Harris hip Score at the end of 3 month is 73.8 and at end of 6 months is 84.3. Seven patients who were manual laborers went back to their original work None of the patients developed thigh pain.

Screw back out occurred in one patient, but the # united by 16 weeks.

Two patients treated with PFN developed abductor lurch.

One patient developed Superficial wound infection which settled down with antibiotics. There was no case of deep infection .

We don't have encountered post operative 'Z' effect which is due to sliding of screws and femoral shaft # at the tip of the nail in our follow up.

**Discussion**

The PFN is an effective intramedullary load - sharing device. It incorporates the principles and theretical advantages of the Zickel Nail, Dynamic hip screw and locked intramedullary nail.

Biomechanically PFN is more stiff, it has shorter moment arm i.e. from the tip of lag screw to the center of femoral canal whereas the DHS has a longer moment arm undergoes significant stress on weight bearing and hence higher incidence of Lag screw cut out and varus malunion. The larger proximal diameter (15 mm) of the PFN given additional stiffness to the nail. Minimal blood loss, shorter operative time, early weight bearing are all advantage of PFN whereas the DHS has a longer operative time & more blood loss.

In the current study the union rate was 100% with one case of varus malunion. There were no cases of preoperative and postoperative femoral fractures.

The average blood loss in patients treated with the PFN nail was 227 ml. The results were comparable with Bellabarba et. al. 2000.

| | | |
|---|---|---|
| **Average blood loss** | **I.B. Schipper et.al. 2004**<br>**220 ml** | **Our series**<br>**227 ml** |

Average operating time in our series was 67.7 minutes.

In our initial cases operating time was on the higher range (Range 43 – 82 min). With experience the operating time reduced.

Results were comparable to the series of Bellabarba et. al. 2000.

| | **I.B. Schipper et.al. 2004** | **Our series** |
|---|---|---|
| **Average operating time** | **60 min** | **67.6 min** |

The use of image intensifier was 117 seconds in patients treated with the PFN, which is considerably less than that of Halder’s series (5.4 minutes in Halder et. al. 1992 series).

In comparison, mechanical failure of DHS occurs in 10 to 20% of cases primarily due to cutting out of the lag screw superiorly (Wolfgang, Bryant and O'Neill et. al..1982). The operative blood loss in patients treated with DHS is higher (250 ml in Radford et. al… 1993 series). Full weight bearing is delayed in patients treated with DHS (Leung et. al.. .1992).

Peroperative and postoperative femoral fractures have been documented in patients treated with the PFN. Multiple factors have been implicated like implant design and operative technique. Decreases in implant curvature, diameter, over reaming of femoral canal by 1.5 to 2mm, insertion of the implant by hand and meticulous placement of the distal locking screws without creating additional stress risers decreases the complication rate of femoral shaft fracture (I.B. Schipper et.al. 2004). Patients with narrow femoral canal and abnormal curvature of the proximal femur are relative contra-indications to intramedullary implants (Halder et.al 1992). We have followed these recommendations in our series. Hence in our series we don't have encountered any preoperative and postoperative femoral shaft fractures. A larger cohort of patients is necessary to document the incidence of preoperative and postoperative femoral shaft fractures, which is a limitation of our study.

In our series the incidence of abductor lurch in the post operative period was 17.5% Gluteus medius tendon injury has been reported in 27 % patients with the use of Trochantric entry nails (Mc Connell et. al. 2003). The abductor lurch may improve in many numbers of patients and may remain static in some patients. Since the follow – up period of this study is short which is a limitation of our study, we could not definitely quantify the number of patients who developed permanent damage to abductor musculature.

In short the PFN is a better implant with distinct advantages over the DHS. With adequate surgical technique, the advantages of the PFN increases and the complication rate decreases.

# CONCLUSION

Intramedullary nailing with the PFN has distinct advantages over DHS like shorter operating time and lesser blood loss for unstable trochanteric fractures.

Early mobilization and weight bearing is allowed in patients treated with PFN thereby decreasing the incidence of bedsores, uraemia and hypostatic pneumonia.

The incidence of preoperative and postoperative femoral shaft fractures in PFN can be reduced by good preoperative planning and correct technique, adequate reaming of the femoral canal, insertion of implant by hand and meticulous placement of distal locking screws.

PFN is a significant advancement in the treatment of unstable trochanteric fractures which has the unique advantage of closed reduction, preservation of fracture hematoma, less tissue damage during surgery, early rehabilitation and early return to work.

# PROFORMA

NAME : AGE : SEX :

ADDRESS :

IP No : Unit : DOA : DOS : WARD :

Mode of Injury : Side of Injury : R/L

Associated Injuries : Head / Abdomen / Pelvis / other limb injuries

Boyd and Griffin Classification

Investigation

- Plain X- Ray Pelvis AP and Lateral views
- Urine albumin /sugar
- Blood Hb / BT / CT / Urea / Sugar / Grouping and typing
- Chest X –Ray
- ECG

**Initial Management :**

Improvement of General Condition

Closed reduction / Upper tibial pin traction / Bohler Braun splint

Details of other treatment particulars

**Surgery**

- Interval between injury and surgery
- Patient positioning
- Operating time
- Entry Portal
- Method of fracture reduction
- Type of implant
- Length and diameter of nail
- Length of lag screw
- Details proximal and distal locking
- Amount of blood loss / blood transfusion
- Fluoroscopic exposure (in seconds)

**Complications**

Improper placement of nail splitting of entry site

Varus positioning

Peroperative femoral shaft fracture

Failure of distal locking

Early Postoperative -Infection

Abductor lurch

**CLINICAL AND RADIOLOGICAL ASSESSMENT DURING FOLLOW UP PERIOD**

| | | |
|---|---|---|
| Fracture union at | - | weeks |
| Harris hip score | - | 3 months |
| | - | 6 months |

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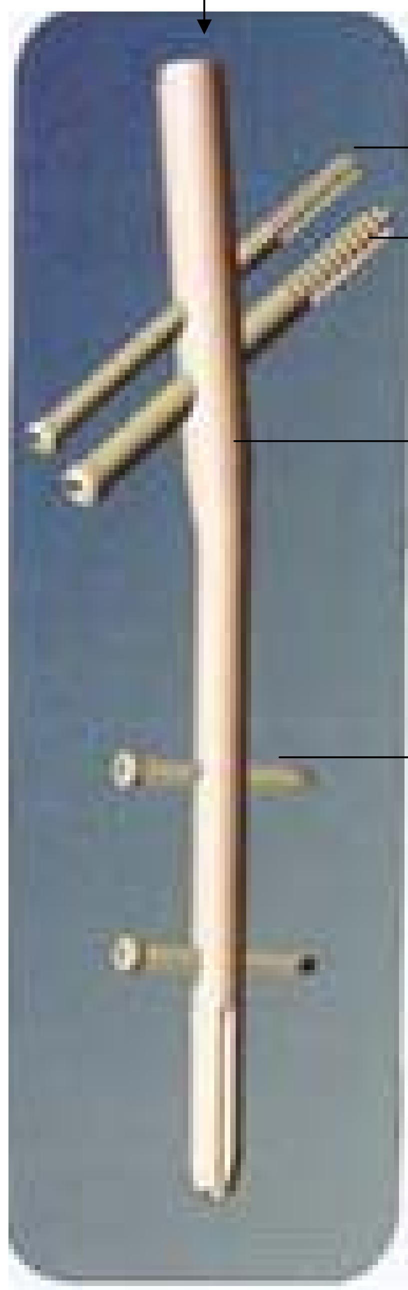
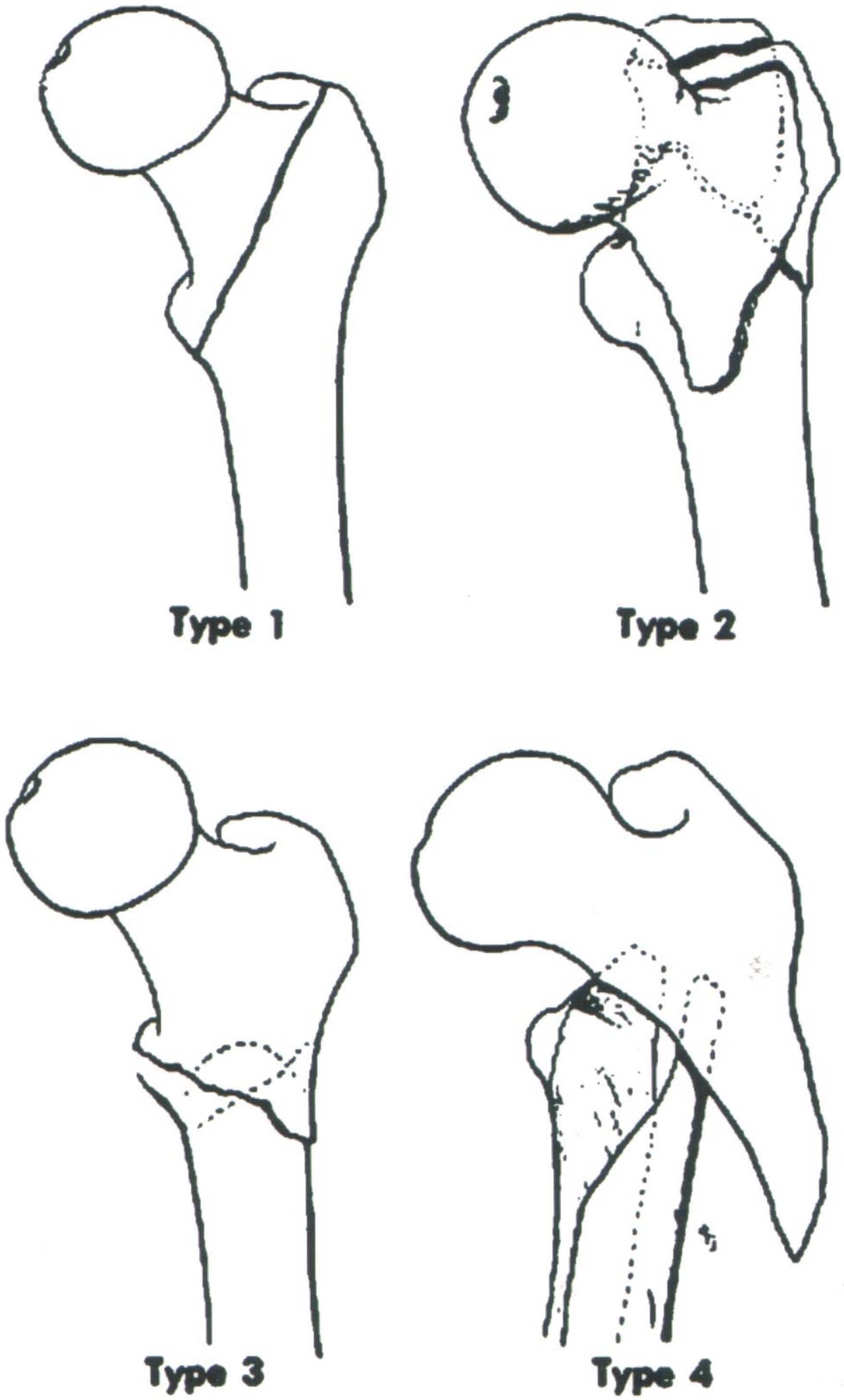
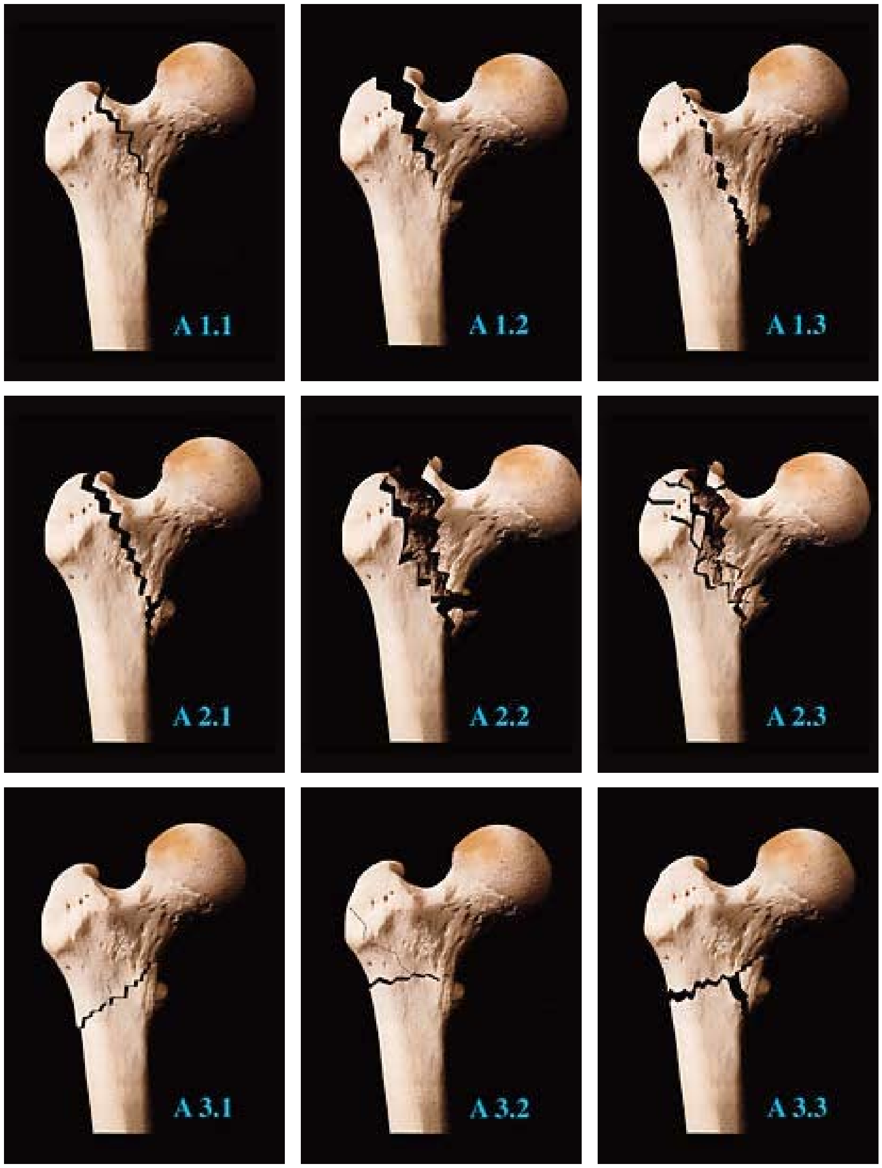
# PROXIMAL FEMORAL NAIL 135$^{O}$



# <u>BOYD AND GRIFFIN CLASSIFICATION</u>



# THE AO CLASSIFICATION




## AO CLASSIFICATION

**A1: Simple (2-fragment) pertrochanteric area fractures**

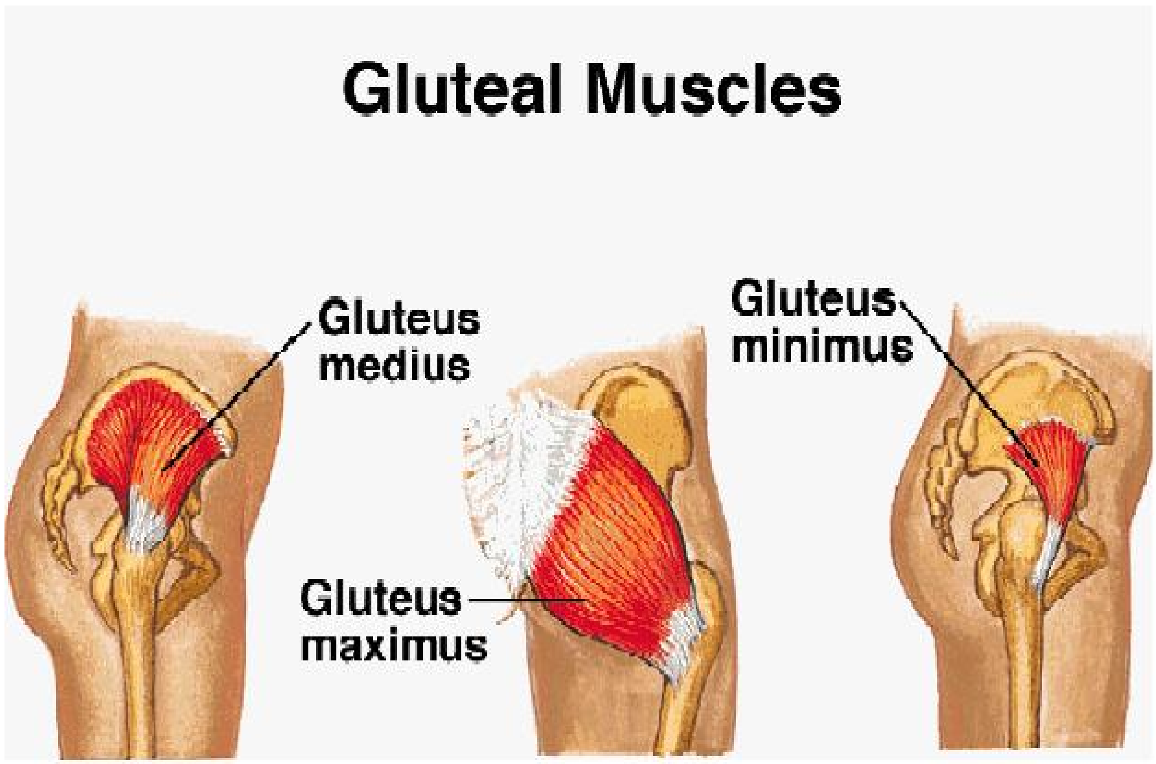
A1.1 Fractures along the intertrochanteric line
A1.2 Fractures through the greater trochanter
A1.3 Fractures below the lesser trochanter

**A2: Multifragmentary pertrochanteric fractures**

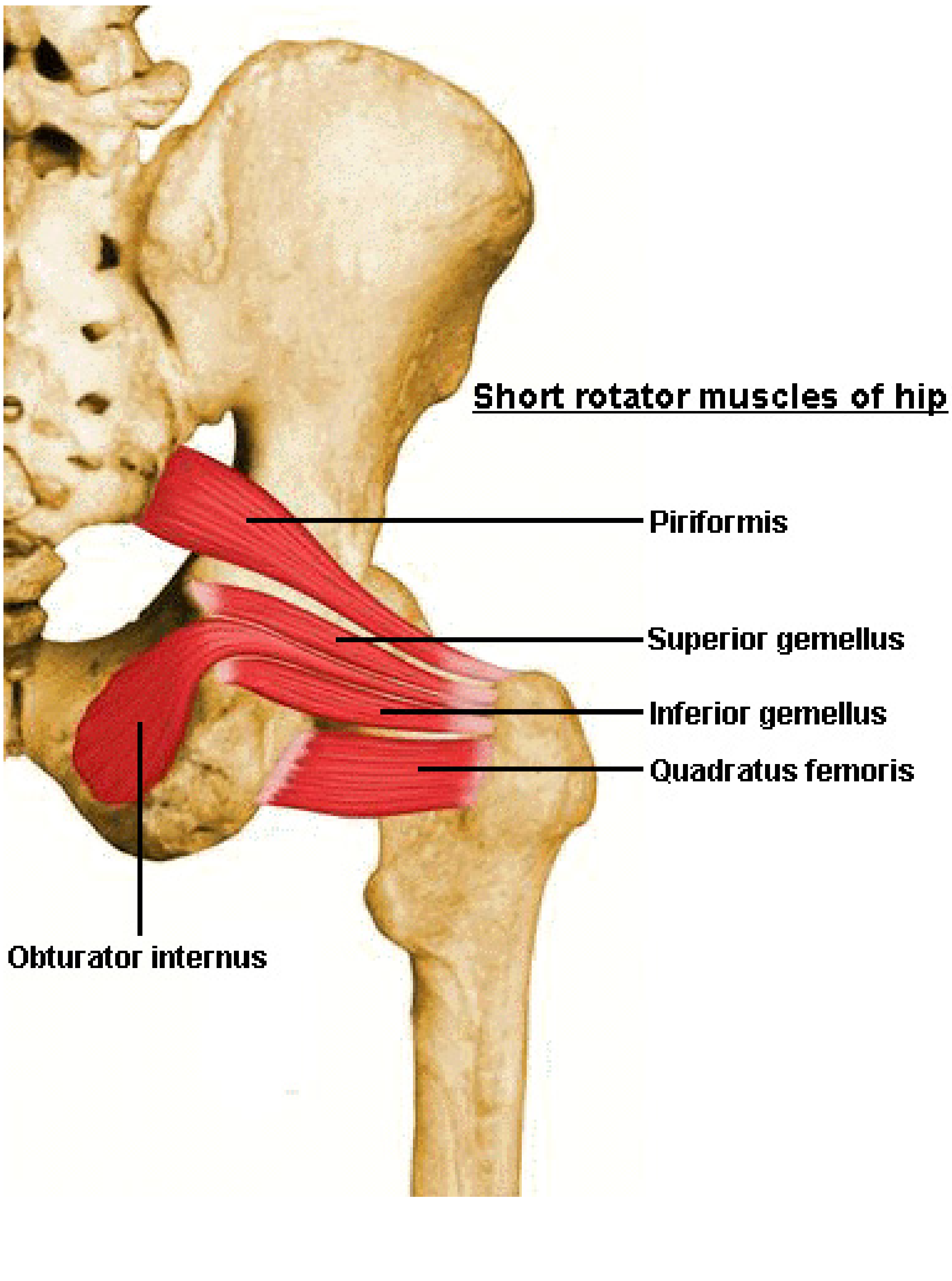
A2.1 With one intermediate fragment (lesser trochanter detachment)
A2.2 With 2 intermediate fragments
A2.3 With more than 2 intermediate fragments

**A3: Intertrochanteric fractures**

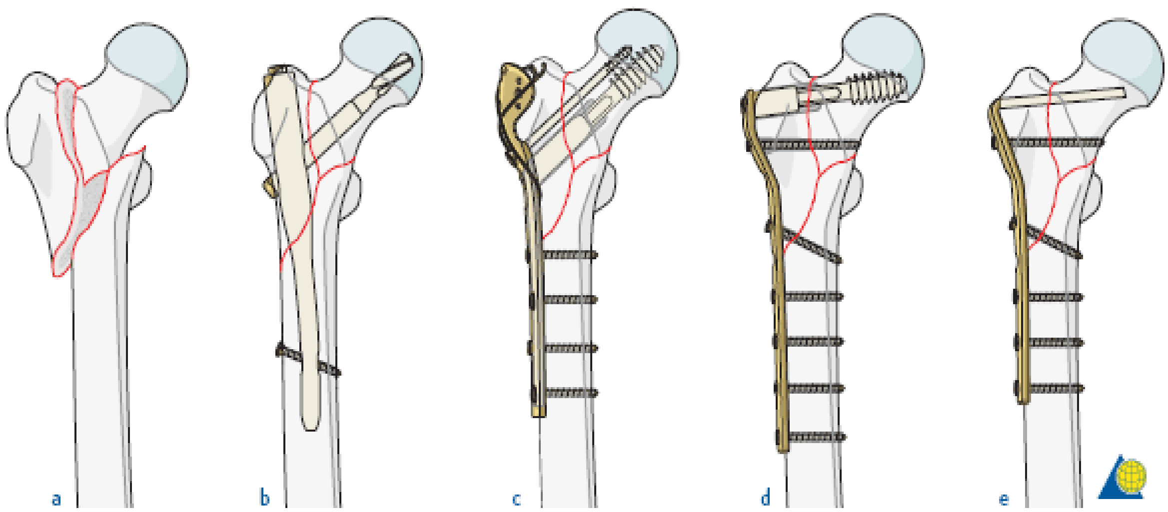
A3.1 Simple, oblique
A3.2 Simple, transverse
A3.3 With a medial fragment


Gluteal Muscles
Gluteus medius
Gluteus maximus
Gluteus minimus

## POSTERIOR VIEW OF GREATER TROCHANDER



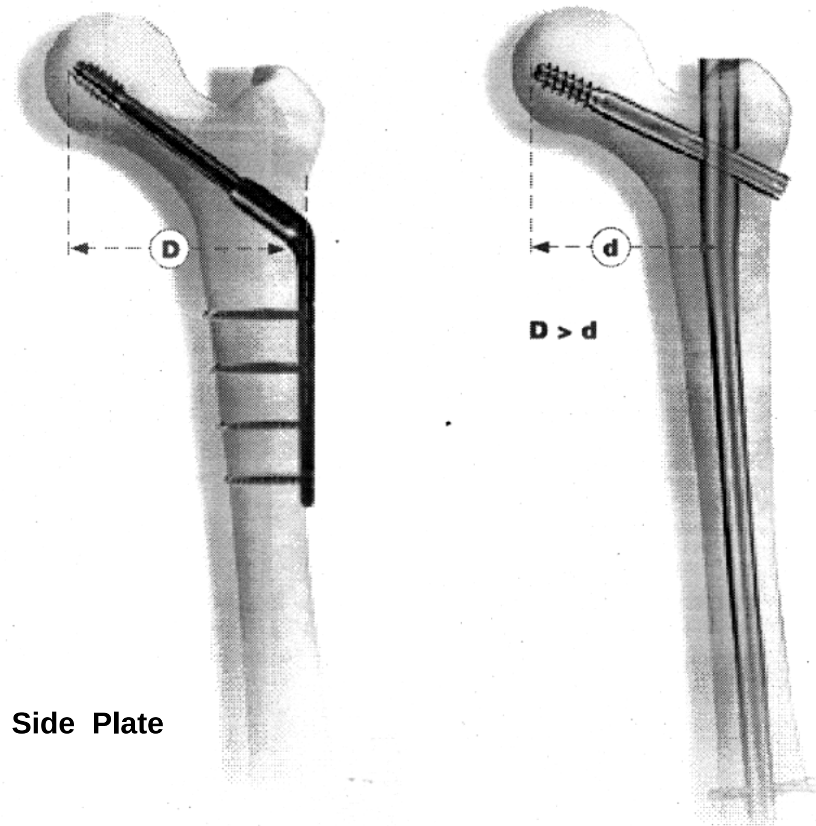
**VARIOUS METHODS OF FIXATION UNSTABLE INTERTROCHANTERIC FRACTURE**




b This fracture is preferably fixed with an intramedullary device (PFN, TFN, etc). c Alternatively, the DHS with an additional trochanter stabilizing plate and a tension band wire can be used.

d–e The fracture can also be fixed with the dynamic condylar screw or a condylar blade plate. The dynamic condylar screw or the blade is placed high in the proximal fragment. The plates have to be put under tension. Patients cannot fully bear weight immediately after surgery.

# ANALYSIS




Side Plate

Intramedullary System

**Strength and Stability**

The biomechanical superiority of the intramedullary system offers significantly greater strength and stability compared with the side plate, in clinical use.

**The Biomechanical Advantage over Side-Plate Systems**

Since the load-bearing axis of the closer to the hip joint fulcrum, the effective lever arm on the implant and femur is significantly shorter than with an extramedullary plate. The reduction factor is equivalent to d/D as shown is approxmately25% [1]). The resultant force is transmitted directly down the femur using a nail system. If a side-plate system is used, the femur shaft may be weakened through a high amount of locking screws. This increases both the strength and reliability of the biomechanical repair.

**Rehabilitation Benefits**

The extra strength effectively gained through the biomechanics of the PFN combined with improved control of axial telescoping and rotational stability may allow earlier weight-bearing even in patients with complex or unstable proximal and combined ipsilateral shaft fractures. Early mobilization, dynamic compression, and a less traumatic operative technique increase the chance for rapid recovery and reliable bone union.

## COMPARISON OF RESULTS WITH SIDE PLATE DEVICE & PFN FOR A UNSTABLE TROCHANTERIC FRACTURE

**TYPE III – INTER TROCHANTERIC FRACTURE**

**TREATED WITH DHS**

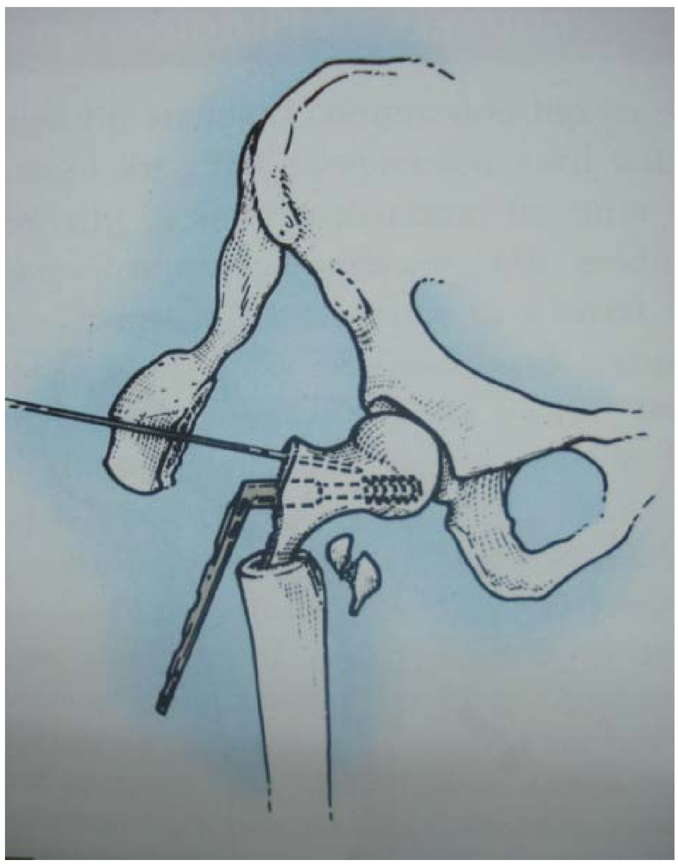
Extramedullary position of the DHS
Results in
Excessive collapse of Proxmal Fragment
Gross Medialisation of Disital Fragment
Screw Cut out
Non union at Fracture site

**TREATED WITH PFN**

Intramedullary position of the PFN

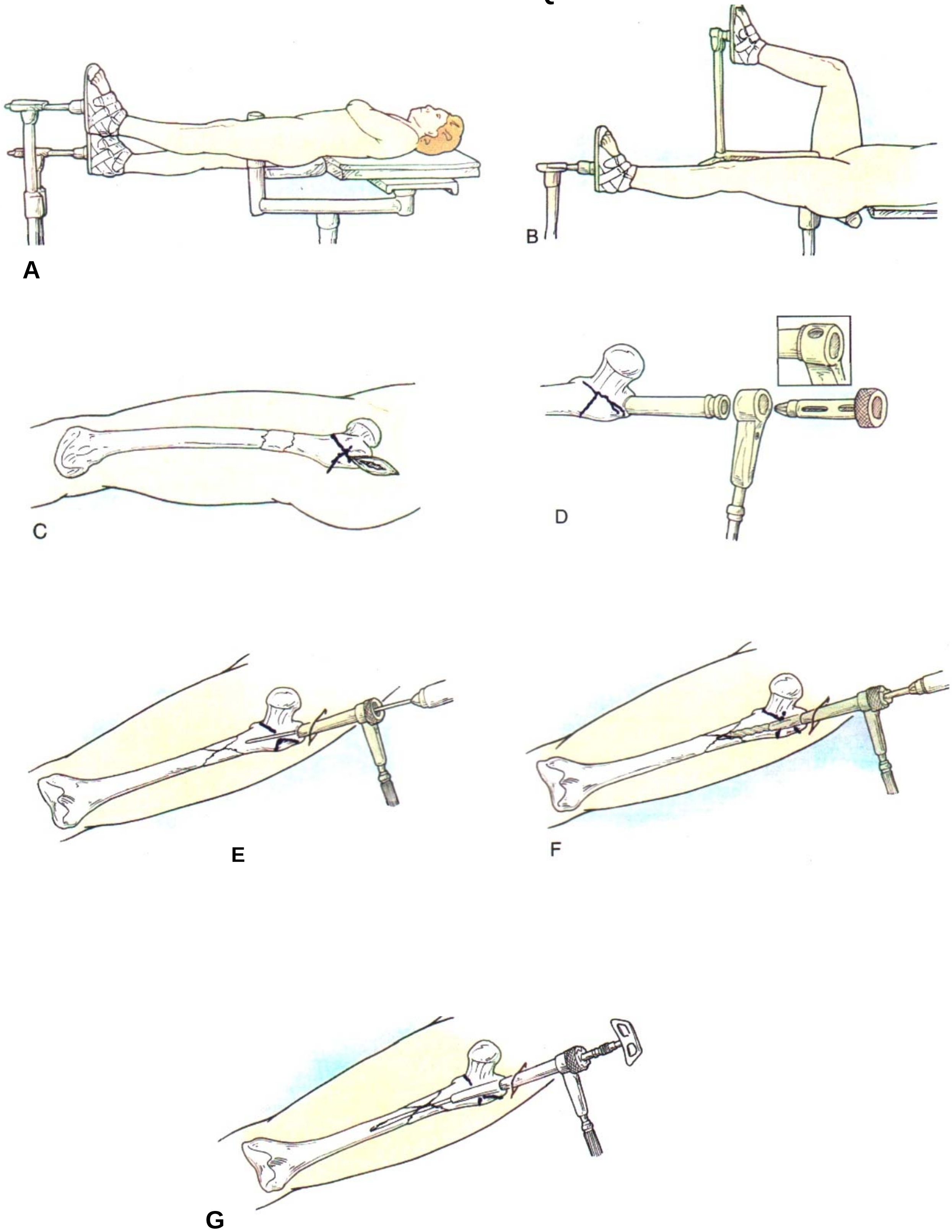
Prevents Excessive collapse of Proxmal Fragment
Prevents Gross Medialisation of Disital Fragment
Union at Fracture site

# DIMON AND HUGHSTON OSTEOTOMY
# FOR UNSTABLE TROCHANTERIC FRACTURE

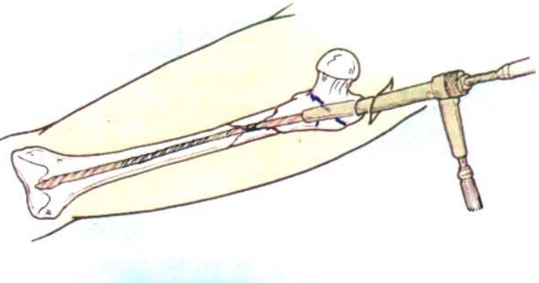


# INSTRUMENTS

## SURGICAL TECHNIQUE



# SURGICAL TECHNIQUE



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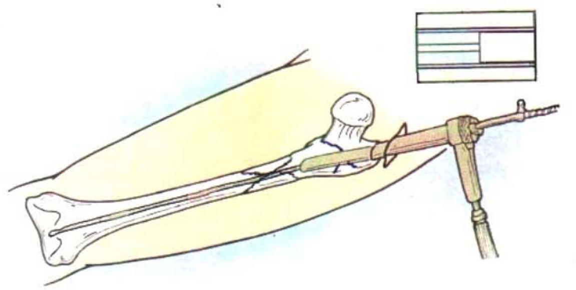

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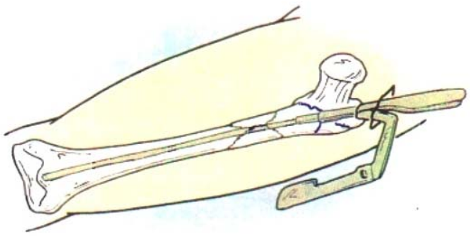

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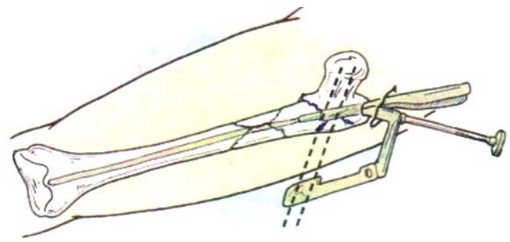

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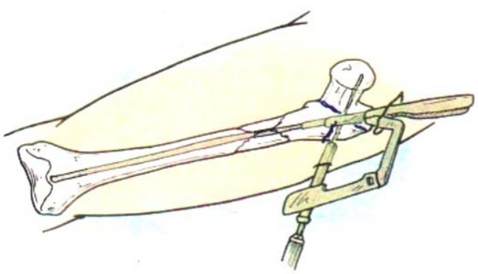

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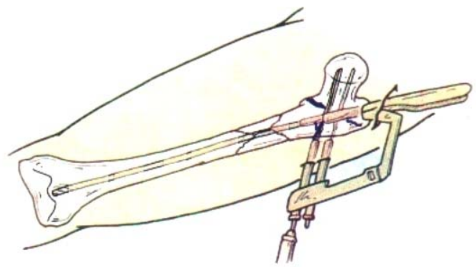

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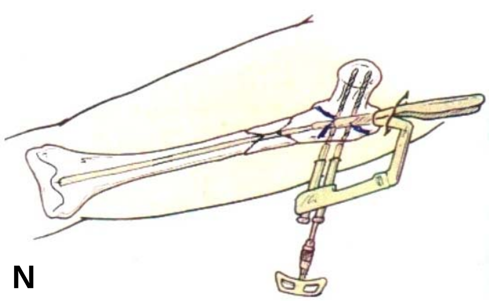

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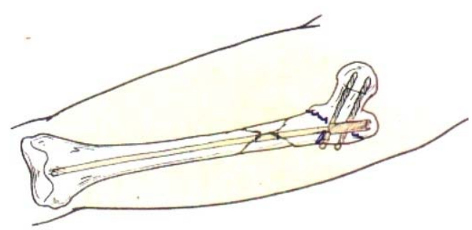

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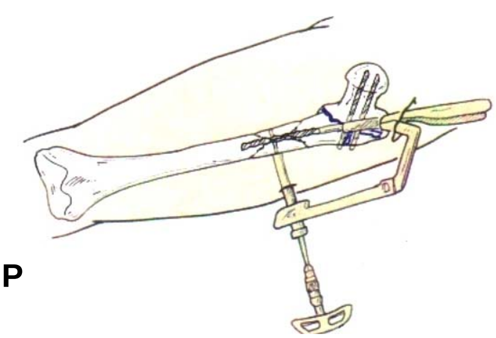
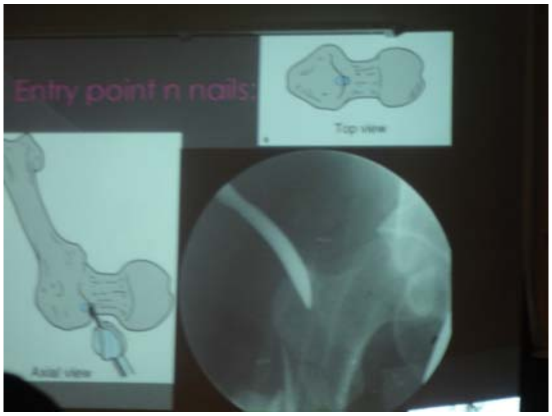
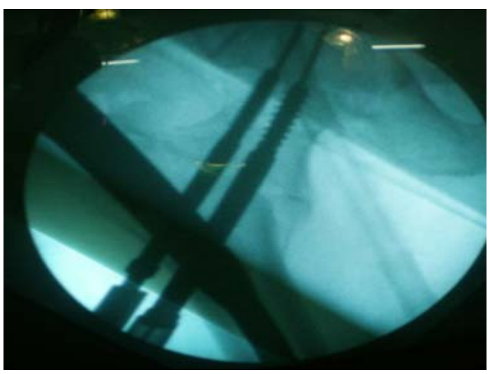


P

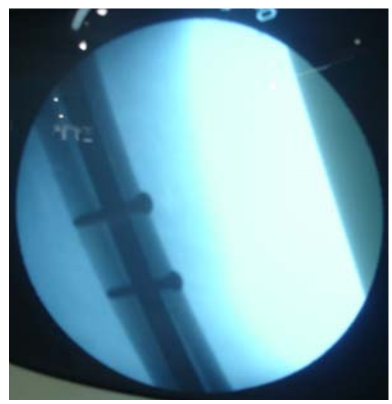
## C- ARM PICTURE




ENTRY POINT

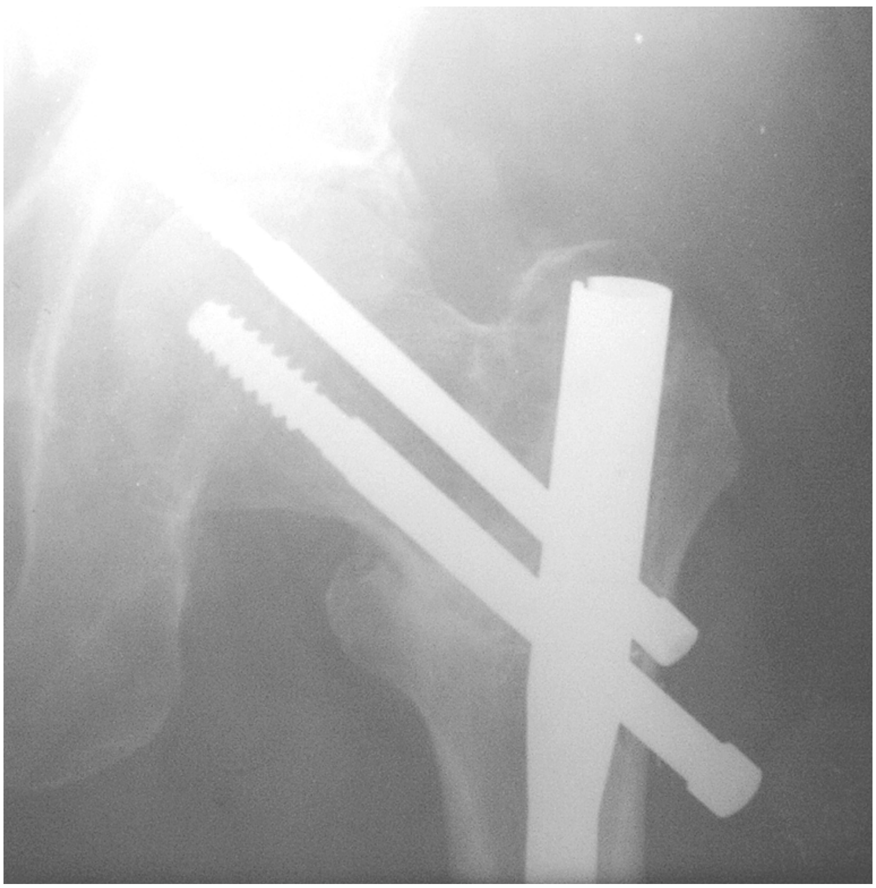


PROXIMAL TARGETING

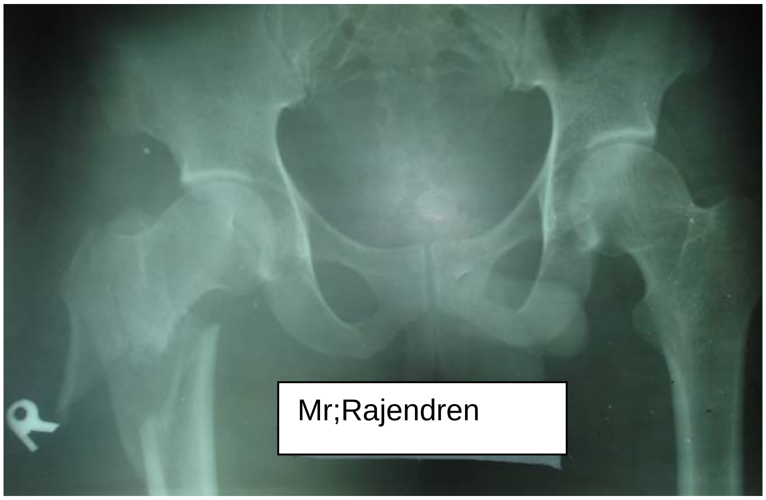


DISTAL TARGETING

## ‘Z’ EFFECT IN PFN



## Case -1 :Mr. RAJENDRAN




PRE OP X-RAY

6 Weeks POST OP X-RAY

6 Months POST OP X-RAY

**FUNCTIONAL OUTCOME**

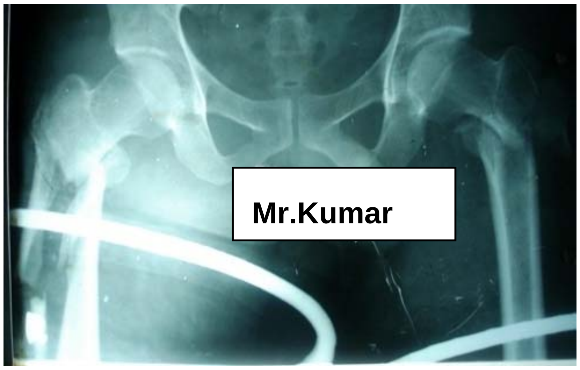
**Case -2 : Mr. SENTHIL**


PRE OP X-RAY

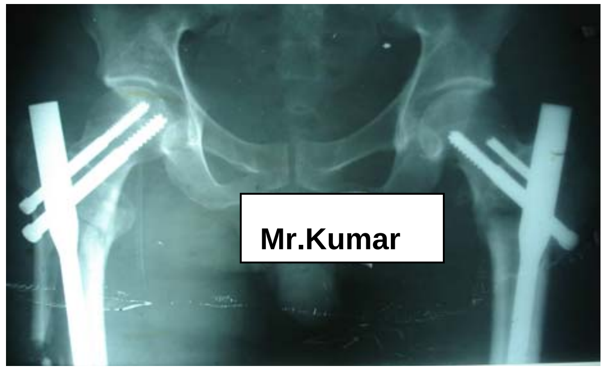

6 Months Post OP X - Ray

**FUNCTIONAL OUTCOME**

**Case -3 :    Mr. KUMAR**




PRE OP X-RAY




IMMEDIATE POST OP X-RAY


**6 MONTHS  POST OP X-RAY**

**<u>FUNCTIONAL OUTCOME</u>**

**Case - 4 : Mr. RAMAN**


PRE OP X-RAY

6 WEEKS POST OP X-RAY

**<u>FUNCTIONAL OUTCOME</u>**

# MASTER CHART

| S. No. | Name | Age | Sex | IP.No | Mode of injury | Classification | Side | Associated injury | Interval between injury and surgery | Reduction open/closed | Nail size | Operating time (mins) | Blood Loss (ML) | Fluoroscopic exposures (sec) | Complications | Time for union (weeks) | Harris hip score | | Followup in months |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | 3 mon | 6 mon | |
| **PROXIMAL FEMORAL NAIL** | | | | | | | | | | | | | | | | | | | |
| 1. | Mr.Rajendran | 22 | M | 03763 | Acc. Fall | IV | R | Olecranon # (R) | 9 Days | Open | 9x400 | 82 | 325 | 230 | Nil | 15 | 72 | 81 | 15 |
| 2. | Mr.Andisamy | 27 | M | 17432 | RTA | III | R | | 7 Days | Closed | 9 | 53 | 150 | 150 | Nil | 12 | 80 | 83 | 14 |
| 3. | Mr.Senthil | 32 | M | 24597 | RTA | IV | L | | 4 Days | Closed | 9 | 72 | 225 | 163 | Abductor Lurch | 13 | 70 | 79 | 12 |
| 4. | Mrs. Banumathi | 38 | F | 29543 | RTA | III | R | | 10 Days | Open | 9 | 78 | 275 | 120 | Nil | 13 | 71 | 81 | 11 |
| 5. | Mrs.Mary | 63 | F | 30721 | Acc.Fall | III | R | | 8 Days | Closed | 11 | 43 | 150 | 96 | Nil | 12 | 79 | 90 | 11 |
| 6. | Mr.Kumar | 45 | M | 33799 | RTA | III | L | | 6 Days | Closed | 9 | 63 | 175 | 75 | Abductor Lurch, Screw Back out | 16 | 70 | 84 | 10 |
| 7. | Mr.Kumar | 45 | M | 33799 | RTA | IV | R | | 6 Days | Closed | 9x400 | 77 | 275 | 150 | Nil | 16 | 73 | 81 | 10 |
| 8. | Mr.Raman | 70 | M | 54007 | Acc. Fall | III | L | | 7 Days | Closed | 11 | 62 | 200 | 80 | Nil | 12 | 79 | 92 | 9 |
| 9. | Mr.Murugan | 35 | M | 55002 | RTA | III | L | | 8 Days | Closed | 10 | 65 | 275 | 79 | Nil | 12 | 71 | 85 | 8 |
| 10 | Mr.Shanmugam | 52 | M | 62131 | RTA | IV | R | | 3 Days | Closed | 9x420 | 82 | 275 | 96 | Nil | 13 | 76 | 87 | 7 |
| 11 | Mr.Chandran | 49 | M | 63320 | RTA | III | R | | 6 Days | Closed | 10 | 60 | 175 | 75 | Nil | 13 | 70 | 84 | 7 |
| 12 | Mrs.Lakshmi | 45 | F | 65120 | RTA | III | L | | 7 Days | Closed | 9 | 74 | 225 | 90 | Nil | 13 | 74 | 85 | 7 |
| | | **42.8** | | | | | | | **6.8Days** | | | **67.6** | **227** | **117** | | **13.3** | **73.8** | **84.3** | **10** |